Arctic Integrated Ecosystem Survey
Cruise Report to the Arctic Integrated Research Program

August 1 to September 28, 2017

Compiled by Ed Farley, Kristin Cieciel, Johanna Vollenweider, Carol Ladd, Janet Duffy-Anderson, Lisa Eisner, David Kimmel, Michael Lomas, Ryan McCabe, Calvin Mordy, Phyllis Stabeno, Louise Copeman, Alex De Robertis, Robert Levine, Jeff Guyon, Kathy Kuletz, Libby Logerwell, Franz Mueter, Chris Wilson, Cathleen Vestfals, Geoff Lebon, Catherine Berchok, Nissa Ferm, Harmony Wayner, Marty Reedy, Sigrid Salo, Alex Andrews, Igor Grigorov, Steven Baer, Dan Cooper, Genevieve Johnson, Aleksey Somoff, Natalia Kuznetsova, Alicia Flores, Esther Goldstein, Eric Wisegarver, Adam Spear, Terry Doyle, Zackary Pohlen

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Introduction:

The Arctic Integrated Ecosystem Survey (Arctic IES) is funded as part of the North Pacific Research Board's (NPRB's) Arctic Integrated Ecosystem Research Program (IERP; http://www.nprb.org/arctic-program/). The program and research on this expedition is sponsored by NPRB and the Bureau of Ocean and Energy Management (BOEM). In-kind support for this research cruise is contributed by the National Oceanic and Atmospheric Administration (NOAA).

Our objective is to understand how reductions in Arctic sea ice and the associated changes in the physical environment influence the flow of energy through the ecosystems of the Chukchi and Beaufort seas. Two research expeditions in the Beaufort and Chukchi seas during late summer and early fall 2017 and 2019 were designed to address our objective. Our survey takes measurements of the: 1) physical environment (temperature, salinity, nutrients); 2) seasonal composition, distribution and production of phytoplankton; 3) distribution and standing stocks of zooplankton; 4) assemblages, distributions, abundances, size, diet, and fitness of larval, early juvenile, and adult fishes; and 5) distribution and relative abundances of seabirds and marine mammals.

These Arctic IES measurements are designed to quantify: the physical and chemical environments; water mass, heat, salt, and nutrients; phytoplankton communities and growth rates; the composition, abundance, biomass, and energy content of zooplankton and benthic, pelagic and surface fishes, and the composition and relative abundance of seabirds and marine mammals. Year-round biophysical moorings will provide temporal context of these measurements as well as fish movement and marine mammal calls.

This year's survey was notable for a number of reasons. First, there was no sea ice within our survey region from 72.5N in the Chukchi Sea, into the nearshore regions of the Beaufort Sea and south to the Bering Strait. Ice was present in the northern regions of our survey area to previous surveys that occurred during 2012 and 2013. Second, age-0 Arctic cod were highly abundant on the Chukchi Sea shelf from 69.5N to 72.5N. Our 2012 and 2013 research surveys in this region also found age-0 Arctic cod in high numbers in this region, but our initial interpretation of the survey data is that 2017 stands out as having higher relative abundance of these fish in this region.

Daily radio calls at 6:00, 12:00, and 18:00 on channel 16 were done to update and inform nearby listeners on the status of the survey operations. Daily emails that displayed our progress and planned operations for the day were sent each morning to a distribution list.

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PARTICIPATING INSTITUTIONS

AFSC – Alaska Fisheries Science Center, Auke Bay Laboratories, Juneau, AK

PMEL – Pacific Marine Environmental Laboratory, Seattle, WA

USFWS – US Fish and Wildlife Service, Office of Migratory Bird Management, Anchorage, AK

UAF – University of Alaska Fairbanks, Juneau, AK

BOEM – Bureau of Ocean and Energy Management, Anchorage, AK

MML – Marine Mammal Laboratory, Seattle, WA

OA – Ocean Associates (contract agency for AFSC)

TINRO – Russia's marine research center in Vladivostok

VNIRO – Russia's marine research center in Moscow

UW – University of Washington, Seattle, WA

BLOS – Bigelow Laboratory for Ocean Sciences, East Boothbay, ME

FOCI – Fisheries Oceanography Coordinated Investigations, Seattle, WA

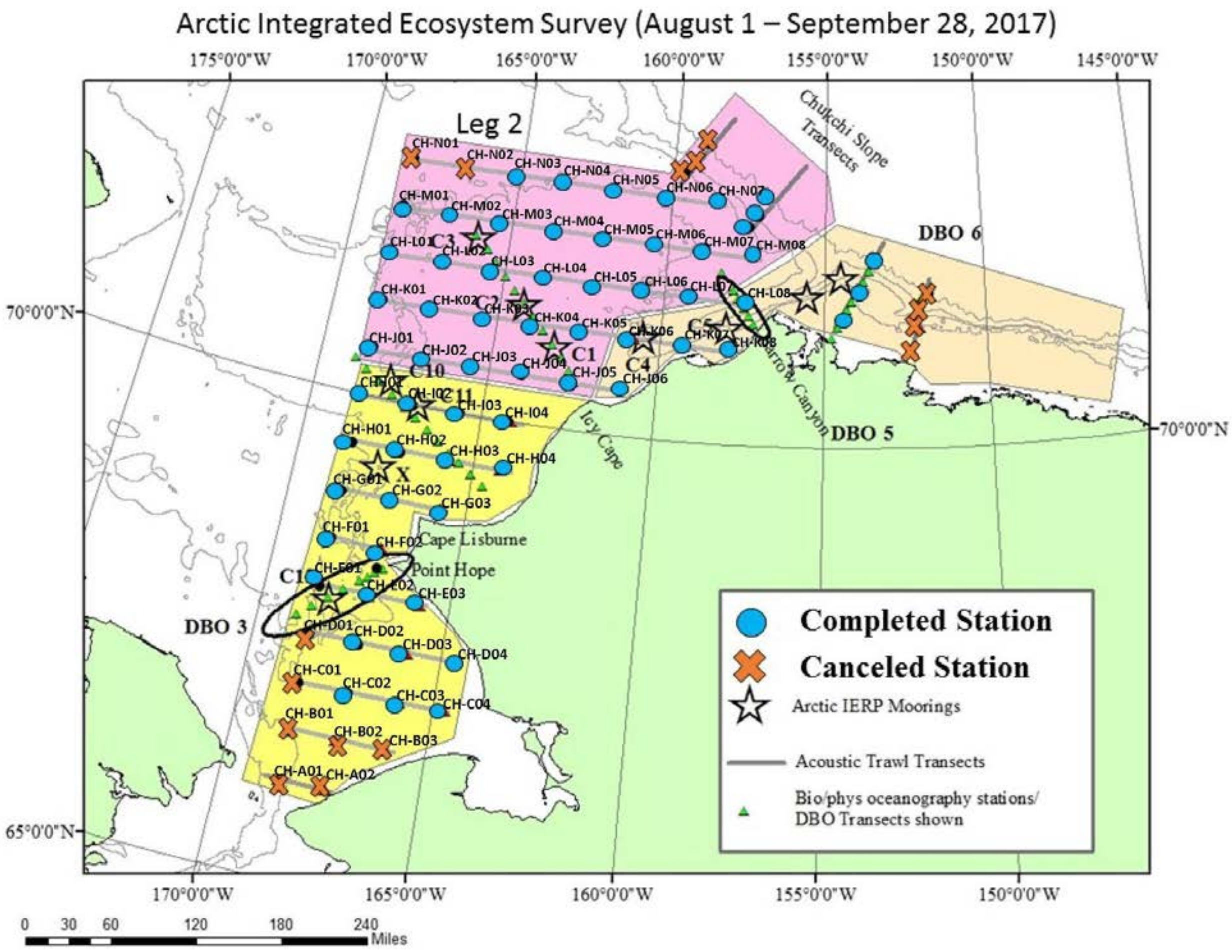
Sea Grant – Alaska Sea Grant, Fairbanks, AK

SCIENCE PARTY CRUISE PERSONNEL

Name	Title	Date Aboard	Date Disembark	Gender	Affiliation	Leg
Johanna Vollenweider	Chief Scientist	8/1	8/24	F	AFSC	1
Robert Levine	Acoustician	8/1	8/24	M	UW	1
Chris Wilson	Acoustician	8/1	8/24	M	AFSC	1
Libby Logerwell	Fish Bio (beam trawl)	8/1	8/24	F	AFSC/FOCI	1
Cathleen Vestfals	Fish Bio/Student	8/1	8/24	F	UAF	1
Geoff Lebon	Ocean/Mooring lead	8/1	8/24	M	PMEL/FOCI	1
Catherine Berchok	Oceanographer 2	8/1	8/24	F	MML/FOCI	1
Lisa Eisner	Bio/Ocean- Phyt	8/1	8/24	F	AFSC	1
Nissa Ferm	Bio/Ocean- Zoo	8/1	8/24	F	AFSC/FOCI	1
Harmony Wayner	Student	8/1	8/24	F	ANSEP	1
Marty Reedy	Seabird Obs	8/1	8/24	M	USFWS	1
Sigrid Salo	Ocean/Mooring	8/1	8/24	F	PMEL/FOCI	1
Ed Farley	Chief Scientist	8/25	9/16	M	AFSC	2
Alex De Robertis	Acoustician	8/25	9/16	M	AFSC	2
Alex Andrews	Fish Bio (CLAMS)	8/25	9/16	M	AFSC	2
Igor Grigorov	Fish Bio	8/25	9/16	M	VNIRO	2
Ryan McCabe	Oceanographer	8/25	9/16	M	JISAO/UW	2
Dave Kimmel	Oceanographer / Zoo	8/25	9/16	M	AFSC	2
Steven Baer	Bio/Ocean-Phyt	8/25	9/16	M	BLOS	2
Dan Cooper	Fish Bio (beam trawl)	8/25	9/16	M	AFSC/FOCI	2
Genevieve Johnson	Bio/Ocean-Phyt	8/25	9/16	F	Sea Grant	2
Marty Reedy	Seabird Obs	8/25	9/16	M	USFWS	2
Aleksey Somoff	Fish Bio	8/25	9/16	M	TINRO	2
Natalia Kuznetsova	Fish Diet	8/25	9/16	F	TINRO	2
Alicia Flores	Student	8/25	9/16	F	ANSEP	2
Esther Goldstein	Bio/Ocean- Zoo	8/25	9/16	F	AFSC/FOCI	2
Libby Logerwell	Fish Bio (beam trawl)	8/25	9/16	F	AFSC/FOCI	2
Kristin Cieciel	Chief Scientist	9/16	9/28	F	AFSC/ABL	3
Levine, Robert	Acoustician	9/16	9/28	M	UW	3

Igor Grigorov	Invertebrate Biologist	9/16	9/28	M	VNIRO	3
Dan Cooper	Fish Bio (beam trawl)	9/16	9/28	M	AFSC/FOCI	3
Eric Wisegarver	Oceanographer	9/16	9/28	M	PMEL	3
Steven Baer	Bio/Ocean-Phyt	9/16	9/28	M	BLOS	3
Adam Spear	Bio/Ocean-Zoo	9/16	9/28	M	AFSC/FOCI	3
Terry Doyle	Seabird Observer	9/16	9/28	M	USFWS	3
Zackary Pohlen	Seabird Observer	9/16	9/28	M	USFWS	3
Alicia Flores	Intern	9/16	9/28	F	ANSEP	3
Aleksey Somoff	Fish Biologist	9/16	9/28	M	TINRO	3
Natalia Kuznetsova	Fish Diet	9/16	9/28	F	TINRO	3

R/V OCEAN STARR ARCTIC IES PHASE II CRUISE TRACK & STATION LOCATIONS



CRUISE NARRATIVE

LEG 1 (08/01/2017-08/24/2017) (Johanna Vollenweider)

31 July
Weather in Dutch Harbor has led to flight cancellations and delayed arrival for the science group. Ten of the 12 scientific staff eventually made it into Dutch Harbor after extensive fog delays. N. Ferm and C. Vestfals were unable to secure seats on the plane and will be meeting the Ocean Starr in Nome on August 4.

1 August
This morning scientists boarded the R/V Ocean Starr (K. Cieciel, J. Vollenweider, C. Wilson, R. Levine, L. Logerwell, G. Lebon, C. Berchok, L. Eisner, H. Wayner, M. Reedy, S. Salo) and fish sampling gear was loaded from OSI storage, including the fish sampling table & related gear and the beam trawl gear. A brief on-axis acoustic calibration was conducted in Captain's Bay. The Marport net sounder for the beam trawl was suspended with lines and tested on anchor and underway with limited success. We anticipate better success when the sounder is affixed to the net, properly orienting the sounder for ideal communication with vessel.

After the gear tests, K. Cieciel disembarked and the Ocean Starr began transiting to Nome at ~3:15pm. We began our trip with a celebration and cake for Harmony's 20th birthday.

R/V Ocean Starr docked in Dutch Harbor (J. Vollenweider)

2 August
Today we continued our transit towards Nome. By evening, our travels had gotten us near the mouth of Kuskokwim Bay. Today's seabird observations found the most dominant birds to be Northern fulmars and forktailed storm petrels. Cassin's auklets were also seen. Several fur seals were encountered but no whales were observed visually. We do know that fin whales were in the vicinity, however, from calls we heard via passive acoustic sonobuoys. During today's transit, we deployed 3 sonobuoys, which we use to listen for whale calls. The sonobuoys transmit underwater sounds back to the vessel via VHF, until the vessel is no longer in range after about 10-15 miles.

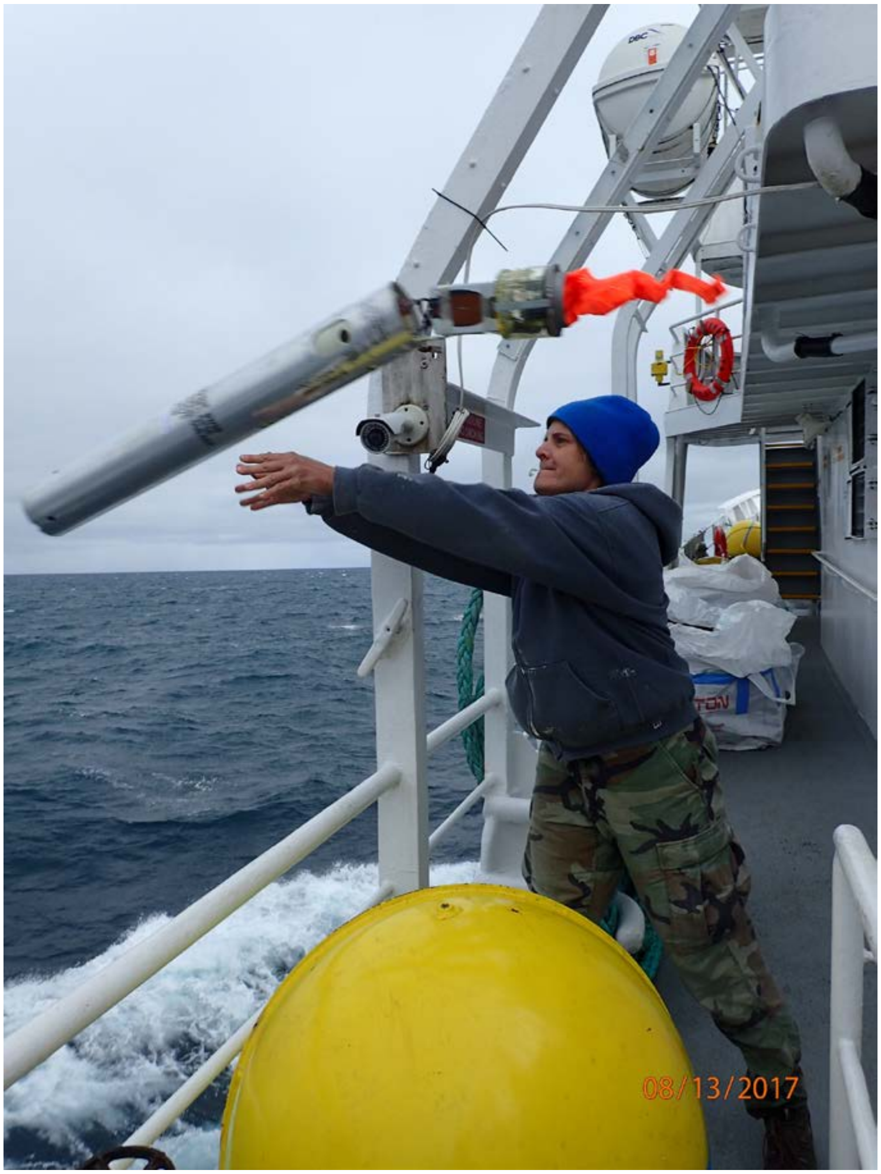
3 August
We continued our transit to Nome via the East side of Nunavik Island to get in the lee and get speed advantages from the current. Our transiting speed ranged from ~8-10.2 kts, generally on the lower end of the range.

4 August
During transit to Nome, we stopped to turn around C. Berchok's Aural mooring (retrieved the old one, put in a new one) in Norton Sound (AI17_AU_NS01). We arrived in Nome at 8:00pm and picked up N. Ferm and C. Vestfals, ADF&G's 2 264 Nordic rope trawls and 1 set of doors, L. Eisner's phytoplankton production equipment. We refueled (~2,700 gallons) and reprovisioned before departing Nome at 11:30pm.

5 August
In the morning we turned around C. Berchok's Aural mooring (retrieved the old one, put in a new one) at AI17_AU_NM1 South of the Bering Strait by King Island. During our transit for the remainder of the day, we set up L. Eisner's production & filtering equipment, N. Ferm's zooplankton station, and got the Nordic trawl spooled on the forward net reel.

We have had spectacular weather thus far. Primarily sunny and calm all day, with fog rolling in the evening. One dead marine mammal floated by, probably a walrus. C. Berchok has continued to hear fin whales from her sonobuoys she deploys periodically.

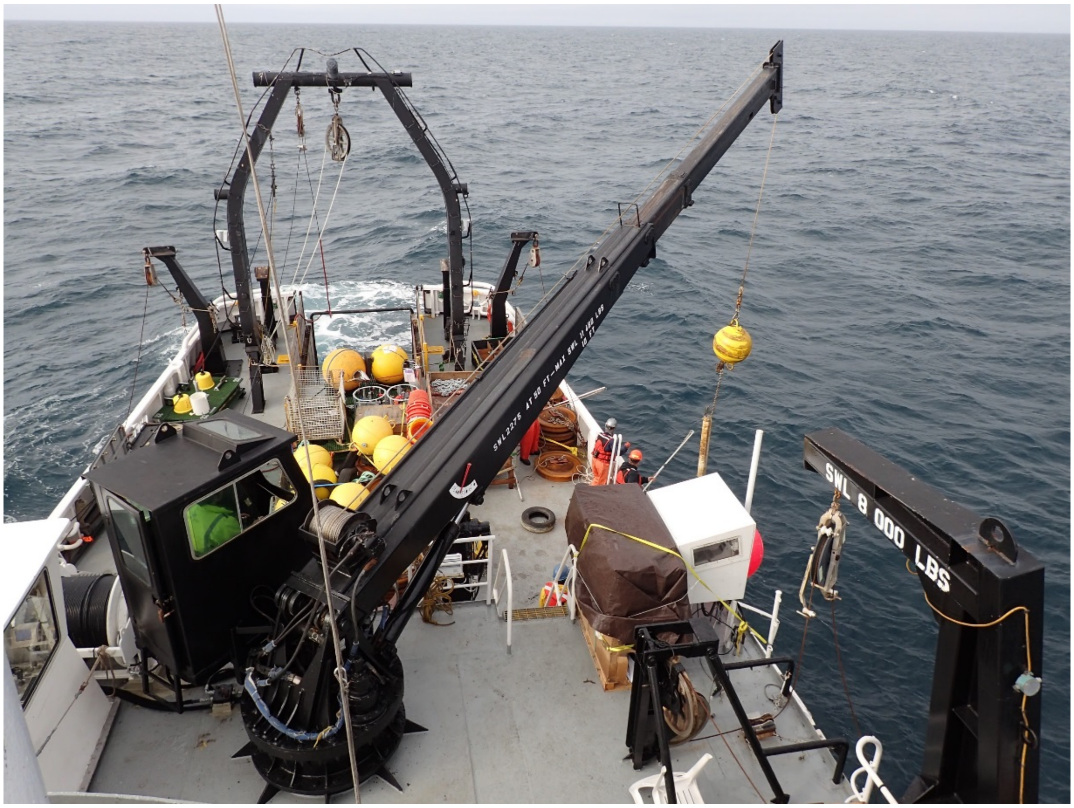
C. Berchok programming a sonobuoy (J. Vollenweider)



C. Berchok deploying sonobuoy (J. Vollenweider)

6 August

We completed mooring operations at stations C12 (Aural & ADCP retrievals, CTD including collection of water for our first primary production experiment), X (Aural retrieval), and C10 (Aural retrieval, ADCP turnaround, CTD, drifter). We saw 3 humpback whales in the evening, the first live marine mammals observed visually of the cruise. The calm weather continues.



Mooring retrieval (J. Vollenweider)

7 August

In the morning we conducted successful test surface tows with the Nordic rope trawl and 3rd wire. We completed the C11 mooring site (Aural turnaround, ADCP turnaround, 2 CTD's (production experiment), first fish mooring deployment and a drifter).

Setting up fish acoustics mooring for deployment (J. Vollenweider)

8 August

We completed mooring activities at C2 (bongo, 2 CTD's (production experiment), Aural turn around, ADCP turnaround, Ice Profiler turnaround, TAPS TurnAround). All operations went smoothly with the exception of the existing TAPS mooring which did not release and failed to surface for us to retrieve. Through grappling with the trawl winches, we were able to recover the mooring.

Also at the C2 cluster of moorings, we encountered a PMEL mooring recently deployed by the USCG Healy. The sensors on the surface float were not vertical as they should be, but hanging off to the side and in the water. Using a Zodiac, we repaired the sensors.


Damaged mooring (H. Wayner)


Repaired mooring (H. Wayner)

We completed mooring activities at C1 (fish acoustic mooring deployment, Aural turn around, ADCP turnaround, and Ice Profiler turnaround).

Of scientific note for the day, in our first bongo tow of the trip we caught an abundance of C. marshallae, 5 saffron cod larvae, 1 capelin larvae, lots of gelatinous pieces, and some crab megalopa.

Weather picked up yesterday to 35 knots. We are currently working in some lee on the nearshore transect between CHJ05 and CHJ06. We plan to sample our first station at CHJ06 later this morning. Weather forecast is 30 kts for 2 more days before dropping off.

9 August

This morning we conducted acoustics between CHJ05 and CHJ06. Afterwards we loaded the Marinovich onto the net reel. CHJ06 was our first station of the survey, where we conducted all operations (including production experiment) except the surface trawl as the station is relatively shallow and we want a little more leeway in deeper water for our first try.

Production experiment (J. Vollenweider)

We plan to do the surface trawl at this station on the way back south. We had our first bottom trawl of the survey at this station, where we caught 2 YOY Arctic Cod, 1 age1+ Arctic Cod, 3 YOY Saffron Cod, 2 age1+ Pollock, MANY Sculpin, Slender Eel blennies, a handful of small Chionocetes Crab, and a mix of other inverts. Libby’s Wheelhouse software with the extra bells and whistles for the bottom trawl was not functioning properly, but we have all the EQ data in CLAMS. The Marport system was still not working, meaning we currently do not have a back-up system for the 3rd wire. We have tried it today on the bottom trawl, in Dutch Harbor dropping it vertically and towing behind the boat, and in Juneau on the Marinovich with no success.

L. Logerwell, K. Vestfalls, R. Levine, C. Wilson sorting trawl catch in the lab. (J. Vollenweider)

Plumb Staff Beam Trawl (bottom trawl) deployment (J. Vollenweider)

Tomorrow we plan for brief Marinovich tests in the morning, acoustics and a MWT between CHK05 and CHK06, and station operations at CHK06.

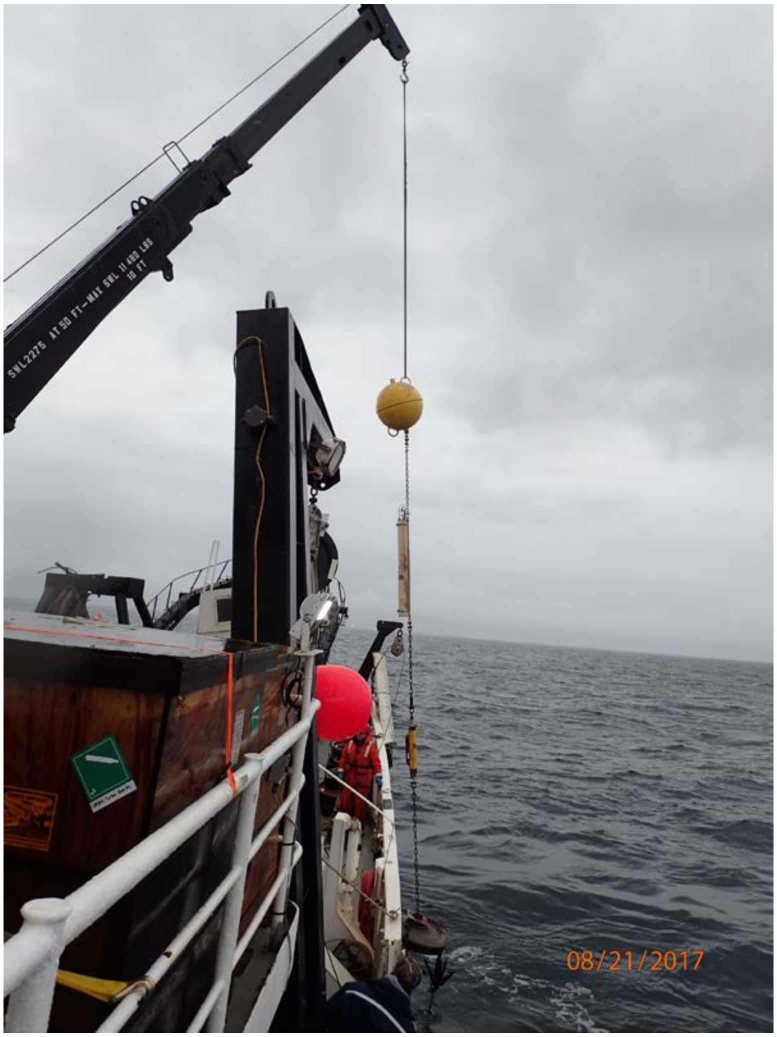
10 August

Thursday was a slow day. In morning as we did our final net test (with the Marinovich), we started to retrieve the net and lost the power to the third wire winch. This is the new winch they had installed in Ballard. The crew determined it was not a hydraulic issue and proceeded to track down the electrical issue for 3 hours before finding a loose wire & resolving it. Luckily we had tested the net with the cod end open and we had a course heading offshore, so other than lost time everything was ok. About the time we got the net aboard, the weather picked up considerably at 35+ knots, preventing us from doing much except doing an acoustic survey along the CH-K line. In the evening we holed up close to shore at CHK-07 alongside the Sikuliaq and the Norseman!

C. Wilson and First Mate Glynnis conducting wheelhouse operations for Marinovich trawl (mid-water trawl).

11 August

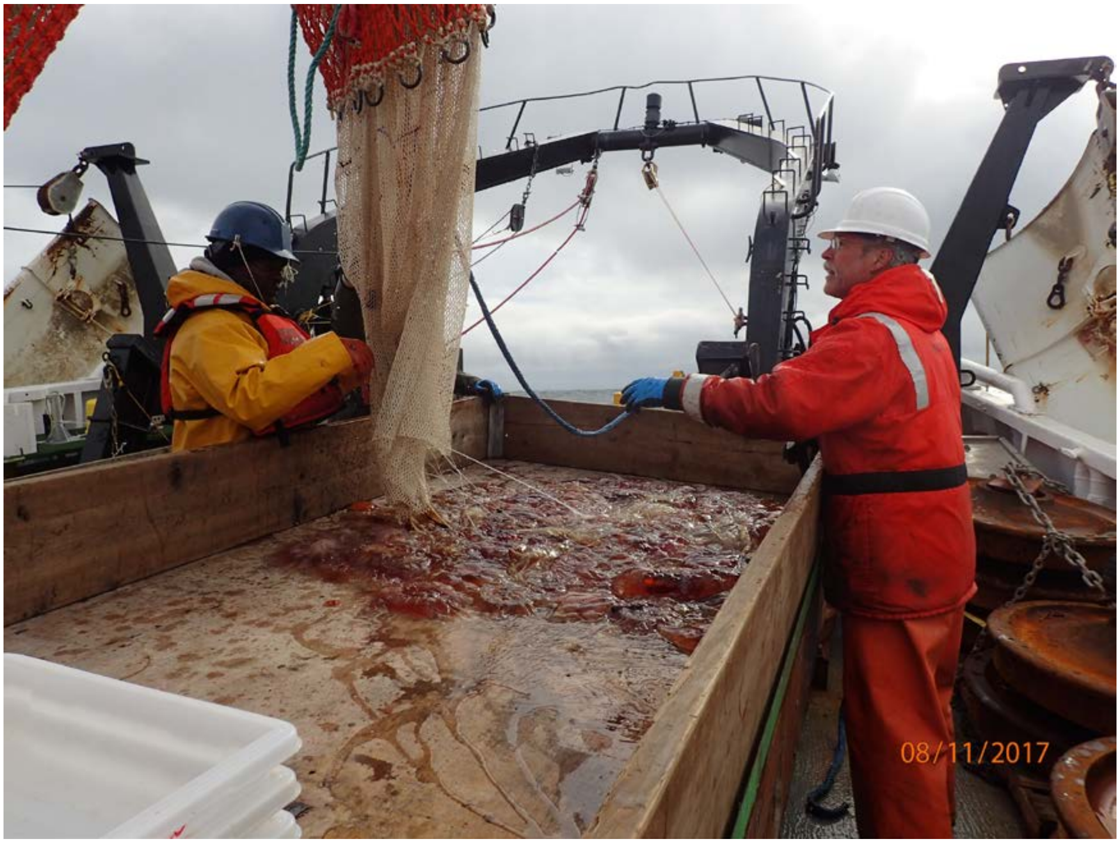
Today we completed station operations at CH-K07, including a bongo, 2 CTDs (production experiment), a surface and bottom trawl. In the surface trawl we caught primarily jellyfish and YOY Arctic cod. No salmon were caught. In the bottom trawl we caught very few fish, primarily Sculpin. We conducted acoustics between CHK06 to CHK08. We completed mooring operations at C4, including an ADCP turnaround, an Aural turnaround, deployment of the third and final fish acoustics mooring, and a CTD.



Mooring deployment (J. Vollenweider)

12 August

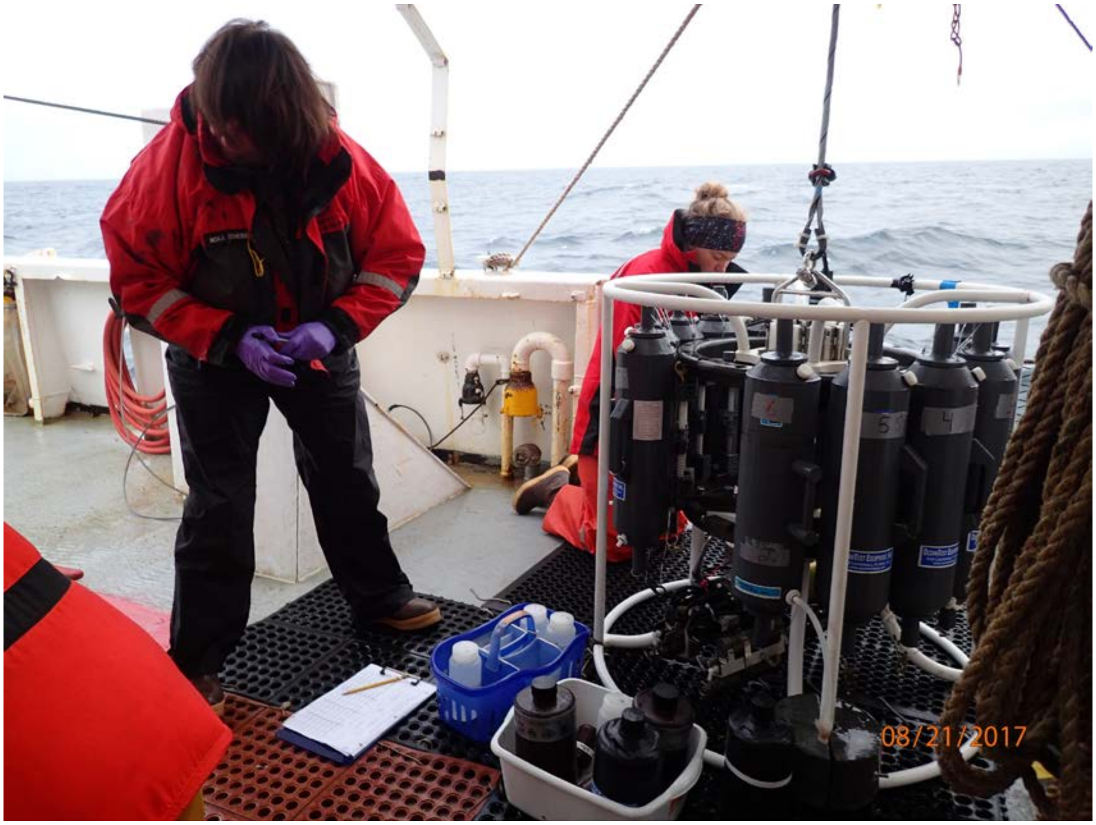
Today we completed station activities at CH-K08, including a bongo, CTD (production experiment), surface trawl and bottom trawl. Catches were relatively similar to yesterday. In the surface trawl we caught lots of jellyfish, and a handful of YOY Arctic cod, YOY capelin and YOY sand lance. In the bottom trawl we caught loads of brittle starfish and a diverse assemblage of invertebrates, and many sculpin. We completed mooring operations at C5, including an Aural turnaround, an ACDP turnaround, and a CTD. We did an acoustic survey between stations CH-L07 and CH-L08. We did a midwater trawl on a scattering layer at 10-15m deep, which resulted in a catch of primarily YOY Arctic cod, and a handful of juvenile Prickleback and Sculpin.



Surface trawl catch of primarily jellyfish (J. Vollenweider)

13 August

Today we completed station activities at CH-L08, including a bongo, 2 CTDS (production experiment), a surface trawl and a bottom trawl. Catches have been relatively similar by gear type. In the surface trawl we caught lots of jellyfish, and a handful of YOY Arctic cod, YOY capelin and YOY sand lance. No salmon have been caught to date. In the bottom trawl we caught about 20 fish, including 1 age 1+ Arctic cod, 1 YOY Arctic cod, Sculpin, Snailfish, and Eelpouts. We also caught loads of brittle stars and some Chionocetes crab, as well as a diversity of other invertebrates. We completed mooring operations at the two un-named stars near Point Barrow, which included turnarounds of a single Aural at each site. We will be positioned to start the first line (the western line) in the Beaufort Monday morning.



L. Eisner and H. Wayner collect water from CTD bottles for nutrient samples and production experiments (J. Vollenweider)

Octopus caught in Plumb Staff Beam Trawl (bottom trawl) (J. Vollenweider)

14 August
Today we got bogged down in the vessel's gear issues. We started off the morning at the deepest station on the westernmost Beaufort line, BFM10. After leaving that station at >1000m and moving shallower we encountered the deep layer of acoustic sign we had been hoping to see, at ~200-300m. As we were fishing the mid-water Marinovich to sample that layer, several hundred meters of the port side warp unwound from the drum in moments and slipped off the boat, leaving us towing the net with the starboard side warp only. Thanks to a very competent deck boss, we recovered all the gear and are ready to fish again this morning. Unfortunately, that ate up much of the day. Once all the gear was on deck, we chipped away at the CTD/bongo stations and got 2/3 of the stations done. In that process though, we discovered the CTD/bongo winch (below decks) was missing a level wind & the wire was stacked up and back-lashed, giving us another 2 hours of trouble shooting. This morning we are starting at the nearshore station and plan to have a productive day and fish our way offshore.

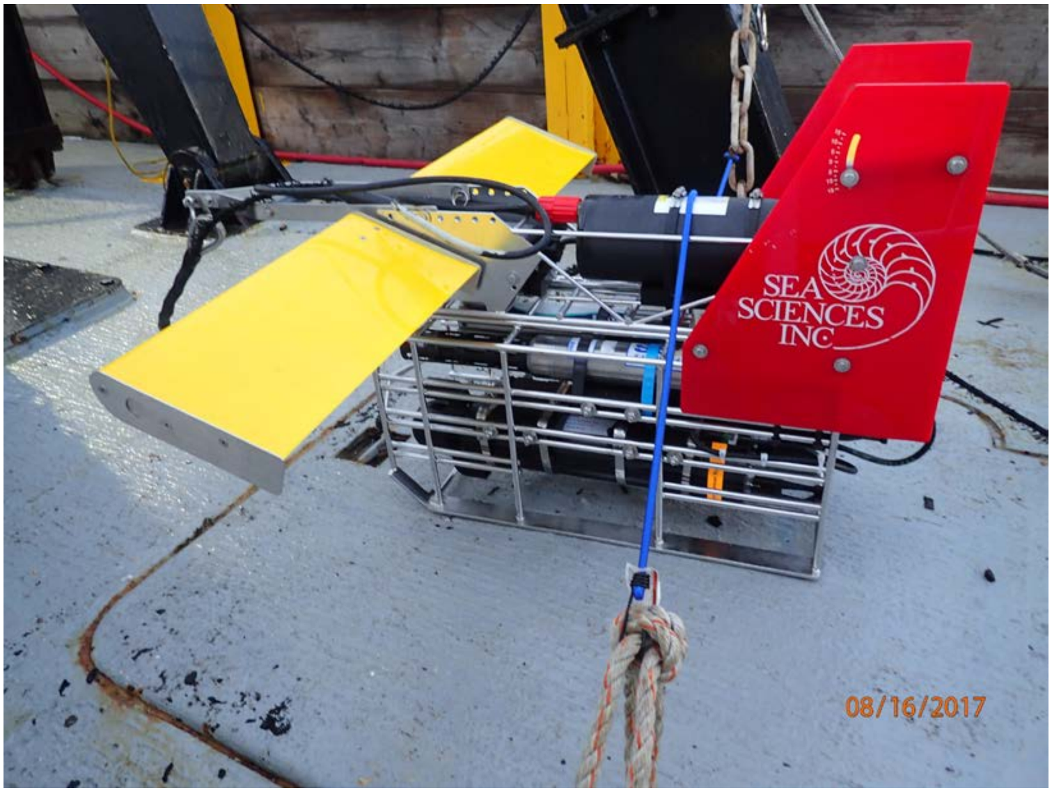
Thanks to the decision to abandon DBO6, this evening we will tow the oceanographic towfish up (south) the Barrow Canyon and start working back south towards Nome. At this rate we should be able to wrap everything else up (knock on wood) in the allotted time.

15 August
Today we completed sampling along the western Beaufort line and then departed the Beaufort Sea, starting our journey south. Activities today include the remaining Arctic EIS stations and CTD/bongo stations along the transect. All planned activities were completed along this line with the exception of a surface trawl at BF-K10 because it was too shallow, and 2 bottom trawls. A production experiment was conducted at BF-4. Libby passed up the bottom trawl at station BF-M10 because we don't have enough wire to fish that deep, and we skipped the bottom trawl at BF-L10 as we ran out of time for the day. We also did an acoustic survey of the entire line with 2 MWT's, and found lots of YOY Arctic cod. The surface trawl caught a few jellyfish. No salmon have been caught yet. The bottom trawl caught primarily sculpin. After completing sampling activities, we are on our way to the mouth of Barrow Canyon to deploy the towed vehicle and tow it through the night as we transit up through the Canyon. Tomorrow we plan to complete the remaining fishing stations we skipped on the way north (CHK06 - all station activities, CHJ06 - surface trawl).

Sorting the trawl catch on deck (J. Vollenweider)

16 August

Today was another day fraught with gear issues, this time all of the oceanography type. This morning at 5:30 we went to launch the oceanographic towfish to tow it up through Barrow Canyon and Geoff discovered that its live wire hadn't been terminated correctly back at the lab prior to coming on the trip. Geoff consulted Phyllis and she prioritized Barrow Canyon over some of the later oceanographic work, so we spent a good part of the day figuring out the problem and reterminating it. We got it up and running and will be towing it through the night with people taking shifts to watch the screen to ensure its swimming correctly. While we were waiting for the retermination, we tried to do a CTD to get Lisa water for a production experiment. At that point the CTD stopped talking with the computer at ~10m and it was determined that a termination was also required for that. We repaired the CTD and will test it first thing tomorrow.



The oceanographic towfish (J. Vollenweider)

Tomorrow we will arrive on the CH-K transect and plan to mop up all our remaining fishing activities there.

17 August

Last night the most unfortunate occurred. We had watched the oceanographic towfish move up and down on its programmed course through the Barrow Canyon collecting data for 3 hours, when all of a sudden at X the tow wire parted for no apparent reason. This is Phyllis's brand new wire on her winch, specific to the instrument. The wire parted cleanly and no one can think of a single reason for the failure. We were in ~150m water with 300m of wire out and the fish had been on a pattern of repeatedly descending to 80m and rising to 10m. We lost communication with the towfish when it was at 50m. Our speed through the water was just under 7.8 knots, and the instrument is rated to 12 kts. This was brand new wire. Three times we drug a series of small anchors over the area where we expected the wire to be laid out, without success. We had woken the captain to have him at the helm for the recovery operations, and at this point he ended the operations for the evening. Seeing the chances of recovery diminishing with each attempt as we were likely dragging the wire to other locations, we agreed that the costs of further salvage attempts the next day were unwarranted.

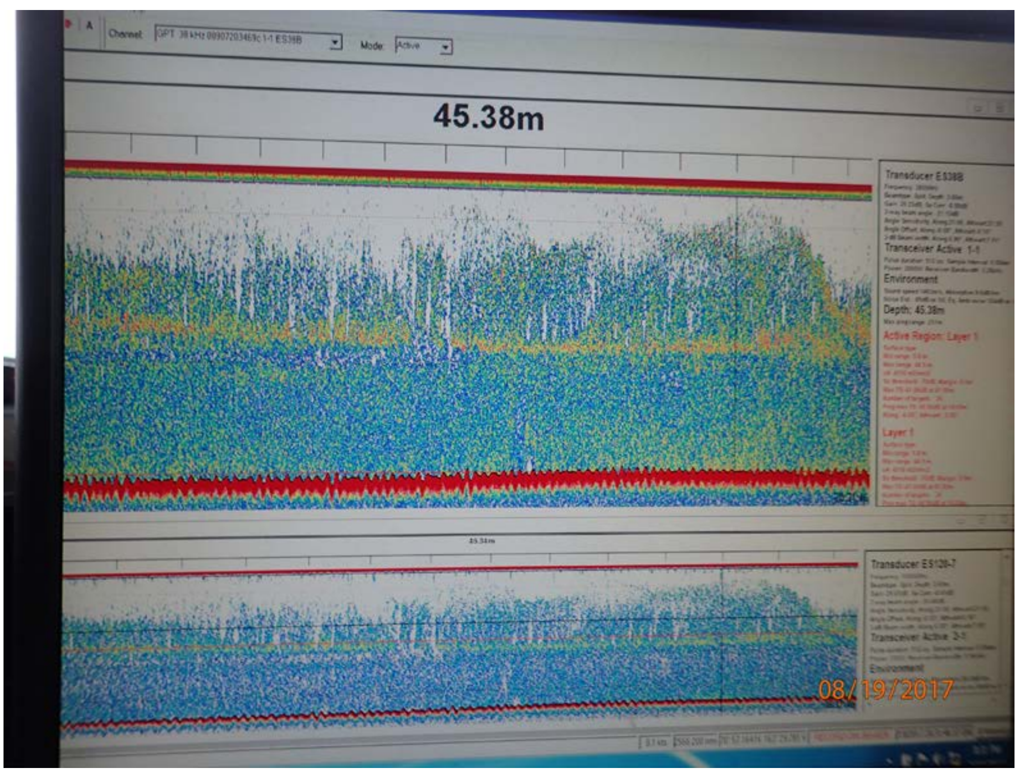
Today we completed a mid-water trawl on a layer of fish at 37-44m deep near station CHK-07, catching primarily young-of-the-year Arctic cod and jellyfish. We also completed all station activities at station CH-K06 (including 2 CTDs to accommodate a primary production experiment). In the surface trawl we caught young-of-the-year Arctic cod, capelin of multiple age classes and 1 juvenile herring. No salmon have been caught yet. In the bottom trawl we caught loads of brittle stars, an age 1 Arctic cod, a Polar eelpout and a snailfish.

We also determined the problem with the CTD was that the o-rings in the vessel's slip ring had failed and it was not functioning properly. The vessel had a replacement slip ring which can be installed.

18 August
Today we completed all fishing activities for leg 1. We did mid-water trawl #6 west of station CH-K06 on a scattering layer at 40-47 m deep where we caught primarily age-0 Arctic cod. Sampling time for this trawl was relatively long as we delayed the tow to move off the target sampling area due to the presence of 2 grey whales. The doors also crossed as we were wrapping up the tow, extending the time spent at this location dealing with the gear. We also did a surface trawl at station CH-J06. 20 minutes into the tow 2 walrus came near the vessel and we hauled back immediately to avoid any interaction. In this tow we caught primarily age-0 Arctic cod and capelin, as well as sculpin, and wolf eels. The net was fishing about the top 20 m of the water column in an area with 30 m of water depth. To date, no salmon have been caught.

19 August
Today we completed 8 oceanography stations (Stations 0.75, 1, 2, 3…7; 70 NM) along the Icy Cape line, for a total of 10 CTDs (including one for L. Eisner’s production experiment at 3 NM) and 4 bongo net tows (bongos at every other station). Tomorrow we will finish the remaining 3 stations and conduct mooring operations at C3 prior to running to the Point Lisburne Line.

S. Olson, C. Berchok, and crewman Cameron. deploy the CTD (J. Vollenweider)



Screen shot of layer of juvenile Arctic cod on echosounder display (J. Vollenweider)

20 August

Today we completed all remaining CTD/bongo stations along the Icy Cape Line (including a production experiment at 11 NM) as well as all mooring operations at C3 (turned around 3 moorings). We will be at the NW end of the Cape Lisburne line first thing in the morning. If all goes well, we hope to get 9 stations done along that line (P Stabeno's minimum number) and drag for Kate Stafford's lost mooring along the way at C10. On paper, this should get us to the Point Hope line mid-morning the next day, and ideally we can finish that as well. To complete both these lines means that we will be working 14-15 hours per day. We have trained the vessel's night shift to do the CTD's so we won't be taxing the vessel crew. As we are only doing CTD's, I believe we have enough scientific staff to spell each other so no one has a particularly long day either.

N. Ferm preserving zooplankton samples (J. Vollenweider)

21 August
Today we conducted CTDs at 11 stations along the Point Lisburne line, including stations LB14-LB4 with a production experiment at LB3. These include the 9 high priority stations that were prioritized by P Stabeno. We also revisited Kate Stafford's mooring at C10 that had not released previously when we tried to release it. On our previous attempt to recover the mooring, after the release failed we tried to grapple it but the block we were using (Logerwell's) kept catching the wire and after 2 hours the effort ceased. Today our grappling efforts were successful and we recovered the mooring in less than an hour.

L. Eisner filtering water samples from CTD (J. Vollenweider)

On a side note, we completely missed the solar eclipse. At this latitude there was a 45% eclipse of the sun, however the dark, low clouds and driving rain prevented any noticeable change in light.

22 August
Today we conducted CTDs at all 8 of the stations along the Point Hope Line (2 CTDs at station PH07 to accommodate a primary production experiment and nutrient analysis needs), and deployed Aural and ADCP moorings at C12. We begin our 245 nm transit to Nome. ETA is 6am Thursday August 24.

23 August
Today we transited from the Point Hope Line towards Nome. ETA is approximately 2am Thursday August 24.

24 August
We arrived in Nome and were able to tie up at the pier for crew exchange. Activities included exchange of scientific staff (with the exception of Libby Logerwell and Marty Reeding who will remain aboard for Leg 2), fueling, offloading black water and garbage, and reprovisioning groceries. In the evening Libby Logerwell gave a talk to the community regarding the Arctic IERP project and Harmony Wayner spoke about her internship in the Alaska Native Science and Engineering Program (ANSEP).

LEG 2 (08/25/2017-09/16/2017) (Ed Farley)

23 - 24 August
Science party arrived in Nome to meet the Leg 1 scientists planning to depart. Some of the science party were treated to Strait Science presentations by Harmony Wayner and Libby Logerwell who described their experiences during Leg 1 of the survey.

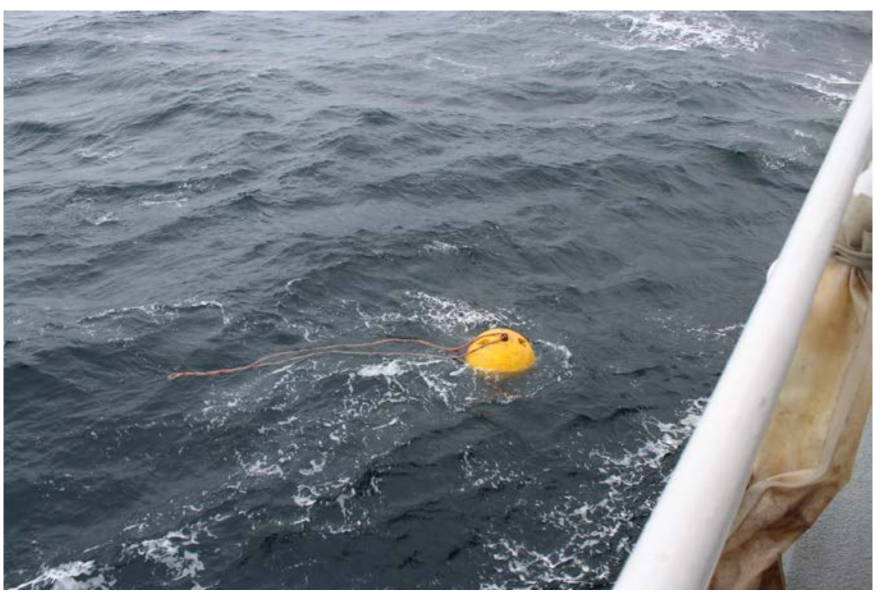
25 August
We left Nome at noon today. Scientists secured cargo for the 3 day sail from Nome to 72.5 N

R/V Ocean Starr at the dock in Nome, AK (photo credit: Harmony Wayner)

28 August
A strong north wind plagued us the first couple of days, considerably slowing our progress. So far we have averaged 5.5 knots, thus understand that it will take an extra day to get up to our starting transect. Regardless, we were able to release one of the Alamo floats in the vicinity of C10 moorning.

30 August
Yesterday we completed two stations and two mid waters and collected water at the second station (CHN04) for production. Things started off fairly smooth today. We missed bottom on the first beam trawl, so had to set again. However, we completed all ops (Juday, CTD, Bongo, Beam trawl) within 1.5 hours....it took us 2.45 hours yesterday morning :) It is snowing this morning...but seas are small chop today. Lots of decapod zoea in the bongo tows and clams in the beam (bottom) trawl. We had small (2-3 cm) Bering flounders and a couple of age 1+ a.cod yesterday in the bottom trawl too. The midwater tows are catching lots of age -0 a.cod and jellyfish that include species such as cyanea with a few melanaster. No problem getting all sample requests for age-0 a.cod at this time. A production experiment was conducted at CHN06.

31 August
We successfully recovered a mooring today that was anchored at 1,000 m depth along the Chukchi/Beaufort slope. The mooring was deployed approximately 2 years ago and contained a device at 500 m depth that records marine mammal sounds.


Mooring recovery. (Photo courtesy of Alicia Flores)

4 September

Happy Labor Day! We continue to make our way through the sampling grid. We lost internet access over the last two days, so no communication was possible. We continue to see age-0 a.cod and a few other fishes in the midwater. We have captured a few age 1+ a.cod and walleye pollock in the beam trawl. Most of the beam trawl samples are collecting inverts with occasional flat fish (small Bering Flounder). Natalia Kuznetsova is doing the on board diet analysis for midwater fishes. Age 0 a.cod are typically feeding on crab zoea (brachyura) and small copepods. All requests for age 0 a.cod have been possible at each mid water location.

5 September

We completed two stations today along the 71.5N line and 1 midwater. Fish and invert comp remains similar to other stations with many age 0 a.cod in the midwater and a mix of older age 1+ (small sample sizes) in the bottom tows. Production experiments continue each day (stations CHM07, CHM05, CHM02, CHL01, CHL04); Dave and Esther are doing the rapid zoop assessment (today we found euphausiids at the second station); Natalia is also processing the zooplankton samples from the Juday and has a nice data set on age 0 a.cod stomach contents for the survey period. We broke transect this afternoon at 1:30 pm and headed south to pick up two moorings. We have both moorings now and are headed back to transect. We will be at the next station along 71.5N (162.2W or CHL 05) by 06:00 tomorrow. We plan to do two stations and two midwaters tomorrow leaving 1 station on the transect to finish Thursday morning.

7 September

Day 14 in the northern Chukchi Sea, and we found ourselves nearshore anchored to wait out a storm. What is striking about this year is that we found no sea ice as far north as 72 deg 30' N, where just 4 years ago, sea ice was found in this region during early September.

11 September

We were down two days due to weather (9/7 and 9/8) but have been able to get 3 stations per day over the weekend. We are now on the 70.5N line heading east and should finish this line tomorrow morning and head to 70N. We are still seeing age-0 Arctic cod in the midwater and continue to collect samples for all requests. There are a few older age a.cod in the bottom trawl and this morning we caught 6 larger saffron cod at the first station in the midwater. The depths are < 50 m and the water column is fairly well mixed from surface to 38 m. Steve has been able to continue daily production experiments (stations CHL06, CHK04, CHK01, CHJ03 with future collection at CHJ05 and CHI02), and we have definitely become efficient at our station operations....i.e. today we were done with: Juday, bottom grab, CTD, bongo, beam trawl, midwater...within 1.5 hours :). This is helping us get 3 stations per day to catch up from our time off.

Photo: Age-0 Arctic cod (photo by Alicia Flores)

Age 1+ Arctic cod (photo by Alicia Flores)

We watched a program filmed in the early 1970s in Barrow about a boy who raises a Polar bear cub (Paqah, queen of the snow bears). It's a good show and includes two of Alicia's relatives!...amazing to see how much ice and snow was around the Beaufort Sea coast during summer in the 1970s when the film was produced.

13 September

We are making good progress on stations and midwaters and will finish the 70 N line tonight. Over the course of the grid, we have seen large aggregations of age 0 a.cod in the offshore regions, very few age 1+ a.cod in the bottom trawls, and fair biomass of jellyfish (cyanea and melanaster) along with a few larger age 0 or 1+ a.cod in the surface waters within nearshore (<35 m depth) regions. Still no juvenile salmon in the surface trawls. On Monday evening, the northern lights were out and Ryan was able to capture a few pictures, one with purple and other colors.

Photo credit: Ryan McCabe

Ryan was configuring the Alamo float that evening, and we plan to deploy the Alamo today as we go by the the mooring locations along this line. We calculated a 54 hour run from our planned last station location tonight, so we will be making our way south.

16 September
We made it back to Nome in the morning and were at the dock by 7:00 am. Hand off to Leg 3 science crew!

LEG 3 (09/16/2017-9/28/2017) (Kristin Cieciel)

16 September
First day of transit for the new science crew, leg 3 officially began. We left Nome at 1900 after safety drills and a ship orientation to make our way north towards the first station at 69.5N 164W. The transit was 54 hours to the first sampling location.

17 September
Full day of transit and gear orientation for all new crew. Held an informal science meeting at 1400 for all science party members.

18 September
Continued transit toward the first station with master station name CH-H04 at 69.5N 164W. Our third leg included a diverse group of scientists. We had two bird observers from US Fish and Wildlife (Terry Doyle and Zack Pohlen), a beam trawl and flatfish expert (Dan Cooper), Zooplankton researcher (Adam Spear), Acoustician (Robert Levine), Oceanographer (Eric Wisegarver), three russian scientists which includes fish, invertebrate taxonomy and fish diet specialities (Igor Grigorov, Aleksey Somoff, Natalia Kuznetsova), fish and jellyfish researcher (Kristin Cieciel), primary production researcher (Steven Baer), and a former Barrow resident who was the blogger, photographer and intern (Alicia Flores).

19 September
We began our sampling at 0800 station CH-H04 (69.5N 164W) with a juday zooplankton net which was deployed by Aleksey, Natalia, and Igor. Operations to follow were the CTD deployed by Eric and Kristin, with water samples including production, oxygen, nutrients, chlorophylls all being taken by Alicia, Eric, and Steven. The benthic grab was Dan, Aleksey, Igor and the bongo deployment was run by Adam with assistance from Aleksey, Igor, and Kristin. The last operation before trawling was the beam trawl overseen by Dan with assistance from Robert and Kristin. We had vessel crew support with all cranes and physical deployment for all trawl nets. The surface nordic trawl net was deployed at 0915 with it being dumped on the sorting table at 1115. Our operations continued for the day with one midwater trawl tow and one more full station at 69.5N 166W (CH-H03) which included a juday, CTD, benthic grab, bongo, beam trawl, and surface trawl. Catches for the day seemed to consist of jellyfish and arctic cod.

First day of sampling for leg 3, scientists A. Somoff, I. Grigorov, and K. Cieciel sorting 1 of the 3 trawls for the day. Photo by Alicia Flores

20 September

Continued on line 69.5N at 0800 with stations CH-H02 (69.5N 167W) and CH-H01 (69.5N 168W), two standard stations with no surface trawls only the juday net, CTD (includes primary production (CH-H01) and water sampling), benthic grab, bongo net, and beam trawl. Due to the absence of surface trawling on the 20th, an opportunity for an additional midwater occurred and it was done on station. In total, two midwater trawls with the marinovich net were deployed at locations based on acoustic sign. The final station of the day was at 69N 168W (CH-G01), standard operations were conducted.

21 September
Winds were picking up to over 35kn. Operations started at 0800 with the standard sequence of the juday net, CTD (includes primary production and water sampling), benthic grab, bongo net, beam trawl and followed by a surface trawl for station CH-G02 (69N 167W). A midwater was fished during transit to station CH-G03 (69N 166W) followed by the standard operations and an additional surface trawl. By the completion of our final station of the day winds were over 40 kn with gusts in the 50s.

Final beam trawl of the day, freshly dumped on the table and showing an assortment of species. Photo by Alicia Flores.

22 September
Weathered out from any operations, had to seek protection from the wind and seas north of Point Hope. No gear was deployed or measurements were taken the entire day. Noticed seven other vessels seeking the same refuge area from the weather. The wind and seas were difficult to deal with even on anchor, gusts were recorded by the ship up to 70 kn. The anchor had difficulty making any purchase in the substrate and due to winds was periodically dragging.

23 September

Pulled anchor at 0900 and started the transit toward the closest station. Winds had come back down to 40kn. Seas were workable in terms of putting gear over the side. We sampled CH-F02 (68.5N 167W), fortunately it was in the lee of the land and provided some protection for all over the side operations. We accomplished a juday net, CTD (includes primary production and water sampling), benthic grab, bongo net, beam trawl and surface trawl. The late start allowed us time to hope for the weather to come down a bit more by the time we moved away from the shelter of land at 68.5N 168W (CH-F01) we were able to deploy a juday net, CTD (malfunctioned), benthic grab, bongo net, and beam trawl. A midwater also occurred in between stations along the transect. Following the last operations for the evening the vessel set a southeasterly course to end up at CH-E03 for the start of operations on the 24th of September.

24 September

The first station was CH-E03 at 68N 166W, gear deployed was the juday net, CTD (malfunctioned), benthic grab (malfunctioned), bongo net, beam trawl and surface trawl. The CTD remained nonfunctional for the rest of the day and was pulled from operations while undergoing repairs. The benthic grab was also no longer working, at some point it had hit the side of the ship and could no longer close. No one on the ship was able to repair the benthic grab. Second station of the day was CH-E02 at 68N 167W, operations were the juday net, bongo net, beam trawl and surface trawl. A midwater trawl was conducted during the transit to the next station. Final station of the day was at 68N 168W (CH-E01). It was an abbreviated station due to gear issues, CTD (tested and malfunctioned), juday net, bongo net, and beam trawl. Through the night we transited south to 67.5N 168W station CH-D01 which was cut due to time limitations but we still had the vessel travel the course along the transect lines for acoustic data collection.

25 September

We completed CH-D02 at 0930 67.5N 167W, operations were CTD (tested and functional), juday net, CTD (includes primary production and water sampling), bongo net, and beam trawl. The CTD had been inoperable for 4 stations and was brought back online after a re-termination of the sea cable and removal of corroded sensors and cables. We moved east to CH-D03 at 67.5N 166W and deployed a juday net, CTD (water sampling), bongo net, beam trawl and surface trawl. The midwater for the day was done right after the surface trawl. The last station for the day was CH-D04 at 67.5N 164W, very near shore and only 19m depth. Due to the shallowness of the station the surface trawl was cut for fear of hitting bottom. Operations were a juday net, bongo net, and beam trawl.


A nighttime beam trawl with a Bryzoan disc dominant catch waiting to be sorted. Photo by Dan Cooper.

26 September

Last day of sampling before final return to Nome. Completed a midwater and three standard stations with surface trawling at two of them (CH-C04 and CH-C03). Stations were completed starting at CH-C04 (67N 164W) at 0800 with a juday net, CTD (water sampling), bongo net, beam trawl and surface trawl. Transiting west to station CH-C03at 67N 166W operations consisted of the the juday net, CTD (with production and water sampling), bongo net, beam trawl and surface trawl. The midwater for the day was conducted enroute to our last station at 67N 167W (CH-C02), where the juday net, CTD (water sampling), bongo net, and final beam trawl were completed at 2300. Following the last beam trawl the northern lights were viewed and everyone agreed that it was a spectacular show for those who were able to catch a glimpse. The vessel continued to travel west to complete running the transect for acoustics at CH-C01 (67N 168W) before changing to a southerly course and heading to Nome.

27 September

Transit to Nome. The winds were on our stern, the transit back took about 27 hours, with a scheduled arrival time at 0230 on the 28th of September. Captain Pete prefered daylight docking for Nome, so we waited until 0830 to move the vessel into the harbor. During the transit spirits were high and clean-up of the lab spaces and deck were underway by 0900. Data entry, and final organization of samples and photos were all completed by 2000 that evening.

28 September

Arrival in Nome was at 0830. This was the final day of the Arctic EIS phase 2 survey. A small contingent of scientists remained onboard for some Bering Sea sampling and a transit to Dutch to offload gear and equipment. Our arrival was met by Alex Andrews, Janet Duffy-Anderson, and Johanna Vollenweider all from the Alaska Fisheries Science Center. They rode the boat back to

Dutch Harbor. Myself (Kristin Cieciel), Robert Levine, Alicia Flores, Zack Pohlen, Aleksey Somoff, Igor Grigorov, Natalia Kuznetsova, Steven Baer and four members of the Ocean Starr crew disembarked the vessel at 1500. Alicia Flores ended her internship with a Strait Science presentation at 1830 at the UAF building in Nome. All fish and soil samples were packaged and being shipped to Juneau Alaska for further dissemination. Oceanography samples were being dealt with on an individual basis. All zooplankton was packaged for Seattle. The Nordic Trawl nets which were graciously loaned by the Alaska Department of Fish and Game were craned off the boat and returned to their storage unit in Nome. Several hundred pounds of chain which had been borrowed from the Nome Harbormaster was also returned, during that exchange musk ox were seen frolicking in the Snake River.

Staging/Destaging

23 July
K. Cieciel, J. Vollenweider, S. Salo, D. Strausz, C. Wilson, R. Levine, and R. McCabe loaded sampling gear aboard the R/V Ocean Starr at the Subport pier in Juneau, AK.

24 July
K. Cieciel, J. Vollenweider, S. Salo, D. Strausz, C. Wilson, R. Levine, and R. McCabe conducted gear trials aboard the R/V Ocean Starr on the west side of Douglas Island in Juneau, AK. The Marinovich was successfully deployed with the vessel's third wire, the only problem being that the trawl winches were extremely slow to pay out/retrieve wire. A subsequent test of the Marinovich with the Marport net sensor was problematic. The Marport was not working, likely due to an uncharged battery. Consequently, the net depth was unknown and the net hit the bottom, breaking the footrope and tearing the belly of the net. Following the net trials, both frequencies of the SIMRAD acoustics were calibrated on- and off-axis in the cove South of Point Hilda and the CTD was tested.

25 July
The final gear was loaded aboard the R/V Ocean Starr in the morning and the vessel departed Juneau for Dutch Harbor.

4 October
The Ocean Starr arrived in Dutch Harbor and offloaded all items for Juneau into a 40' container, frozen samples were shipped and the vessel continued on to Seattle to complete the final gear removal.

DISCIPLINARY SUMMARIES

A. PHYSICS AND NUTRIENTS (Phyllis Stabeno, Carol Ladd, Calvin Mordy, Ryan McCabe, Geoff Lebon, Sigrid Salo, Eric Wisegarver, David Strausz)

Hydrographic profiles and bottle samples

The NOAA PMEL EcoFOCI and University of Washington groups conducted 135 CTD casts over the course of the cruise. The EcoFOCI CTD package consisted of a Sea-Bird Electronics 911*plus* instrument with dual pumped conductivity, temperature, and oxygen (SBE 43) sensors. In addition, a WETLABs fluorometer and turbidity sensor, a PAR sensor, and an altimeter were installed on the rosette frame along with 11 5-liter Niskin bottles. The majority of stations consisted of a single CTD profile, but nominally once per day an additional cast was taken at one station to collect enough water for on-deck phytoplankton primary productivity incubation experiments. Standard CTD profiles included the collection of water at nominal depths of near-bottom, 500 m, 200 m, 100 m, 75 m, 50 m, 40 m, 30 m, 20 m, 10 m, and near-surface. The majority of casts over the shallow Chukchi Sea shelf were limited to approximately 40 m depth, and the CTD was lowered to within 3–5 m of the bottom. The rosette was held in place for at least 30 seconds prior to bottle trips. Filtered nutrient and chlorophyll samples were taken from each Niskin. In addition, salinity and oxygen bottle samples were each taken at a single depth approximately every other cast for use in post-cruise data correction. Oxygen samples were initially saved and then processed onboard during Leg 3 of the cruise. The nutrient samples were frozen onboard in a -20 C freezer. All samples other than the oxygen samples will be processed in laboratories on land. Preliminary processing of CTD data was conducted onboard and hydrographic cross-sections for each transect as well as spatial maps were compiled (see Figs. A1 to A5 in Appendix A). Final processing of the CTD data will occur after bottle samples have been analyzed.

Underway flow-thru system

The NOAA PMEL EcoFOCI group installed an underway system on the ship's seawater intake line (~3.5 m depth) that included a Sea-Bird Electronics thermosalinograph (Stabeno/Ladd), a WETLABS fluorometer (McCabe), and a Satlantic ISUS (Eisner); the ship's GPS information was also fed into the data stream. Filtered chlorophyll, nutrient, and salinity samples were taken approximately once per day. These samples will be used along with the near-surface CTD samples for post-cruise correction of the underway data.

Towed instrument

The NOAA PMEL EcoFOCI group planned multiple transects with a Sea Sciences Inc. Acrobat towed instrument. Unfortunately, during the initial tows the wire parted and the instrument was lost. The R/V *Ocean Starr* attempted dragging to recover the instrument but this was unsuccessful. A separate mission a few weeks later successfully recovered the instrument.

Satellite-tracked drogued drifters

Two satellite-tracked ARGOS drifters were deployed on the Chukchi Sea shelf during Leg 1 of the cruise. These drifters were drogued at 30 m depth and transmit position, time, and near-surface temperature via satellite. The first drifter was deployed near the C10 site, and the second drifter was deployed near the C11 site.

Float ID#	Deploy Date [UTC]	Deploy Time [UTC]	Latitude	Longitude
136868	07-Aug-2017	11:10	70 12.704	167 46.62
136869	08-Aug-2017	02:01	70 05.0	166 45.7

ALAMO Floats

Two Air Launched Autonomous Micro Observer (ALAMO) floats were deployed during Leg 2. The first float (#9120) ceased communicating after deployment near the C10 location. Following analysis of nearby water column density, approximately 50 g of additional ballast weight were added to a second float (#9119) before its deployment near the C11 location. This second float has been communicating and performing as intended.

Float ID#	Deploy Date [UTC]	Deploy Time [UTC]	Latitude	Longitude
9120	28-Aug-2017	13:12	70 12.331	167 47.977
9119	13-Sep-2017	23:30	70 00.547	166 56.400

B. PRIMARY PRODUCTION (Lisa Eisner, Mike Lomas, Steve Baer)

Samples were collected for primary production, chlorophyll a, particulate organic phosphorus, phytoplankton taxonomic analysis with flow cytometry and a FlowCam (Fluid Imaging Technologies), and fatty acid analysis of seston and zooplankton in the Chukchi and Beaufort seas. We sampled 32 stations for total primary production with size fraction production collected at half the sites to estimate phytoplankton growth for the whole community and small (<5 µm) and large (>5 µm) size fractions. Stable isotopes for carbon, nitrate and ammonium were added to measure uptake at 4 light levels (100-1.5% surface irradiance). Water samples were incubated in on-deck incubators cooled with surface seawater for 6 hours and terminated by filtration. Filters were stored frozen until analysis at Bigelow Laboratory for Ocean Sciences.

Phytoplankton taxa and biomass (chlorophyll a)

Total chlorophyll a (a rough estimate of phytoplankton biomass) was collected at all depths at all (~112) CTD stations (883 total samples including whole and size fractions, Fig. B1). Size fractionated chlorophyll a were collected at 3 depths for three fractions (< 5, 5-20, > 20 µm) at production stations and for 2 fractions (< 5, > 5μm) at all other grid stations. Particulate organic phosphorus samples were collected at all production stations and depths; particulate organic nitrogen and particulate organic carbon will be obtained from the primary production sample analyses.

Flow cytometry samples for quantification of small phytoplankton (<20 μm) were collected at 88 stations at all depths. Samples were fixed and frozen at -80°C at sea, until analysis on a BD FacsJazz flow cytometer at the Bigelow Laboratory.

FlowCam analysis for identification of large phytoplankton and microzooplankton (~10 – 200 μm) was conducted on live samples at 75 stations (1-4 depths). Preliminary analysis suggest that during leg 1, dinoflagellates, ciliates and small cells (Fig. B1) were found at the majority of sites (mostly inshore locations) with diatoms present primary along the Point Hope transect (DBO3). During leg 2 the chlorophyll maximum generally was confined below the pycnocline, and was present with a lot of detrital material. There were a lot of small centric diatoms and dinoflagellates, along with some small pennate diatoms, many of which were under 20 μm in diameter. As we moved further south (including leg 3), there were many more large, long (100-200um in length) diatoms like *Proboscia* and *Pseudonitzschia*. Large chain-forming species, namely *Chaetoceros*, were abundant everywhere, along with some *Thallasisosira* and *Thallasionema*, although more abundant further south. These were found broadly throughout the mixed layer (upper 30 m). Future analysis of Flow Cam images will provide more quantitative results and attempt to document the presence of potentially toxic phytoplankton (e.g., *Alexandrium*).

Fig. B1: ANSEP student H. Wayner filtering chlorophyll a samples in the main lab of the *R/V Ocean Starr*. Photo courtesy of Harmony Wayner.

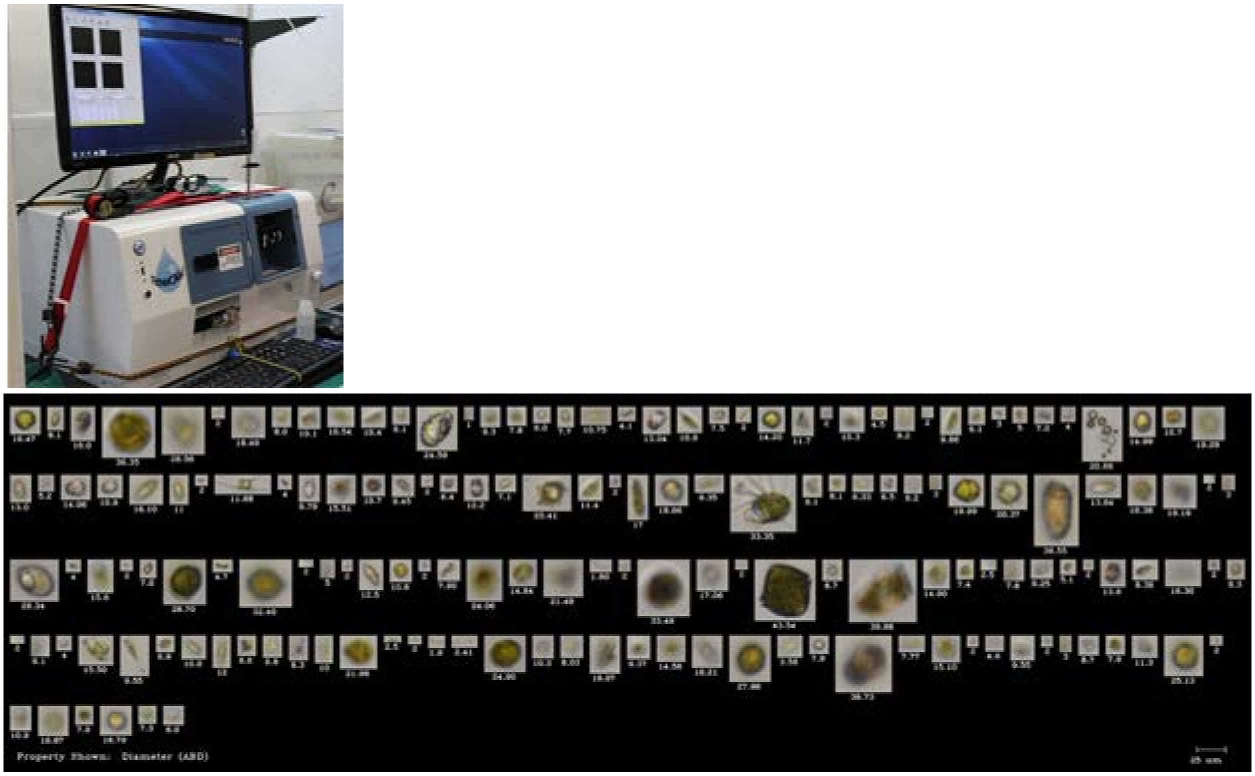


Fig. B2: Flow Cam (top) and subset of Flow Cam photos from a single sample during leg 1.

C. MICROZOOPLANKTON (Dave Kimmel, Mike Lomas, Lisa Eisner)

Microzooplankton were sampled from the Niskin bottles at 3 depths (surface mixed layer, chlorophyll maximum, below chlorophyll maximum) when the water column is stratified. Microzooplankton were preserved in acid Lugol's solution at every grid station, in glutaraldehyde at every other grid station. Microzooplankton samples for molecular analysis were also taken at 6 stations in the northern Chukchi Sea. Microzooplankton samples will be shipped to the Schnetzer laboratory at North Carolina State University for enumeration and identification.

D. LARGE ZOOPLANKTON AND ICHTHYOPLANKTON (Dave Kimmel, Adam Spear, Janet Duffy-Anderson, Esther Goldstein)

Zooplankton

Meta- and mesozooplankton were sampled using a paired Bongo net frame with two 60 cm diameter, 505 µm mesh nets and two 20 cm, 153 µm mesh nets. The bongo frame was towed in conjunction with a SeaCat CTD profiler that recorded temperature and salinity. Bongo tows were processed in the following manner. Net 1 of both the 505 µm mesh and 153 µm mesh was preserved in formalin for later sorting at the Plankton Sorting and Identification Center in Poland. Net 2 of the 505 µm mesh was first sorted for larval fish and these were preserved in ethanol for later identification or genetic analysis (see below, *Ichthyoplankton*). Next, the rapid zooplankton analysis (RZA) was performed to generate rough counts of the zooplankton abundance and community composition. During the RZA, specific taxa of interest were picked from the sample and frozen at -80 °C for later total lipid and fatty acid analysis. At selected stations, a subsample of the zooplankton was then preserved for stable isotope analysis. Finally, the whole sample was preserved in formalin for later transfer to Jared Weems (UAF) who will enumerate and identify the crab larvae present in the sample as part of his PhD project. For the 153 µm mesh sample, a similar procedure was followed. The RZA analysis was done on the sample, but no individual taxa were collected. Rather, the sample was further sieved through a 505 µm mesh net to remove larger individuals; one subsample was preserved for total lipid and fatty acid analyses and another for stable isotope analysis.

The RZA was performed at every grid station, three stations along the Chukchi slope, and one transect in the Beaufort Sea (Fig. D1). Small copepods (< 2 mm) were found in abundance throughout the Chukchi Sea with an average abundance of 2.89 ± 0.71 SD log10 individuals m^{-3}. Small copepods had lower abundances in the northern portion of the grid and increased as the survey progressed southward. The small copepods were primarily represented by *Pseudocalanus* spp., *Oithona* spp., *Metridia* spp., and *Acartia* spp. Large copepod (> 2 mm) abundances were low throughout the northern portion of the grid, particularly in the northwestern portion were very few large copepods were observed (< 3 individuals per m^{-3}). Abundances peaked in the northeastern corner of the survey grid, near the Chukchi Slope, and were also slightly higher in the southern portion of the grid. The primary large copepod encountered was *Calanus marshallae/glacialis* (co-occurring species that are difficult to tell apart). We also observed several individual *Calanus hyperboreus*, a larger, Arctic copepod, in the net samples. This suggests that colder water from the Arctic basin was being transported into the eastern portion of the Chukchi Sea. Euphausiid abundances were highly variable throughout the grid and this was expected as euphausiids are more effective at net avoidance, particularly during the day. We observed increased abundances of small euphausiids (furcilia stage) in the northeast portion of the survey grid. Adult euphausiids were observed in very small numbers along the Chukchi slope (data not shown). Finally, we observed decapods (shrimp larvae,crab zoea, and crab megalopae) only in the northern portion of the grid and high numbers were observed in the northwest portion of the grid.

Shallow stations, those less than 30 meters depth, were dominated by larvae of benthic invertebrates. In particular the pelagic larvae of echinoderms, bivalves and to a lesser extent Pagurids (hermit crab family). *Calanus hyperboreus,* a large calanoid copepod, (≈8mm) was observed at the deepest stations of the Beaufort transect. This copepod is considered an indicator of Atlantic water. Average salinity and temperature recorded using a FastCat at the bottom of zooplankton tows where *C. hyperboreus* were found were 34.3 and -0.3 °C. During the time of sampling both currents and winds were coming from the North possibly pushing deeper water with *C. hyperboreus* up onto the shelf. Highest abundances of zooplankton taxa important as prey resources for Arctic fish and mammals, large calanoid copepods (≈4mm) and Euphausiids, were associated with bottom temperatures below 2°C and salinity greater than 32 (Fig. D2). Movement of colder/saltier water up onto the shelf from arctic basin possibly supports higher abundances of these taxa. Small zooplankton taxa other than copepods were the most abundant over all, these were associated with the bottom water profile of Alaska Coastal water, where salinity was less than 31 and temperatures were above 8 °C (Fig. D3).

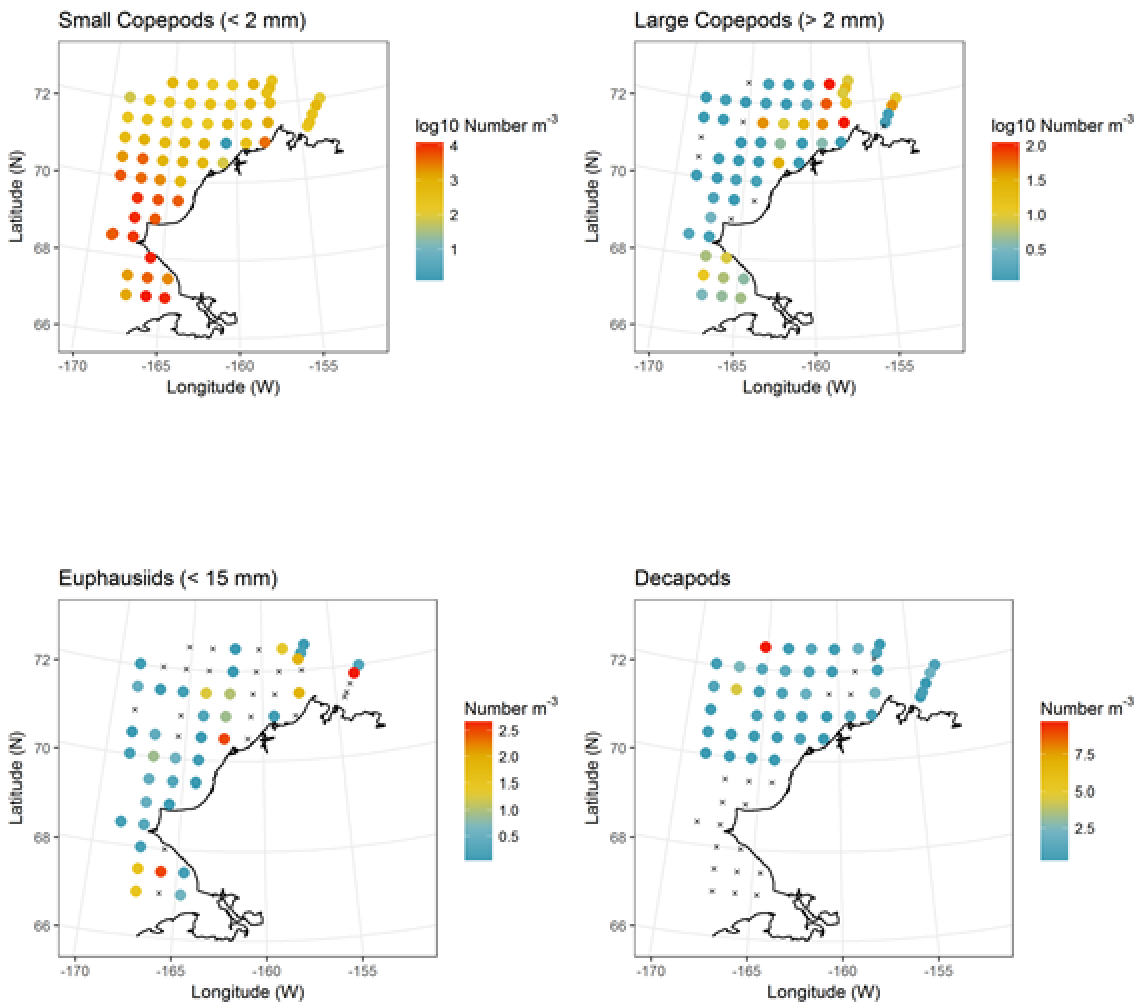


Fig. D1: Zooplankton abundance as determined from Rapid Zooplankton Analysis (RZA) for four broad categories. Each dot represents a Bongo tow at a station and x represents a sample was taken, but the abundance was zero. Note the different scales, for small and large copepods, abundances are log10-transformed for easier visualization of patterns. Euphausiids and decapods are shown as untransformed abundances (number m^{-3}).

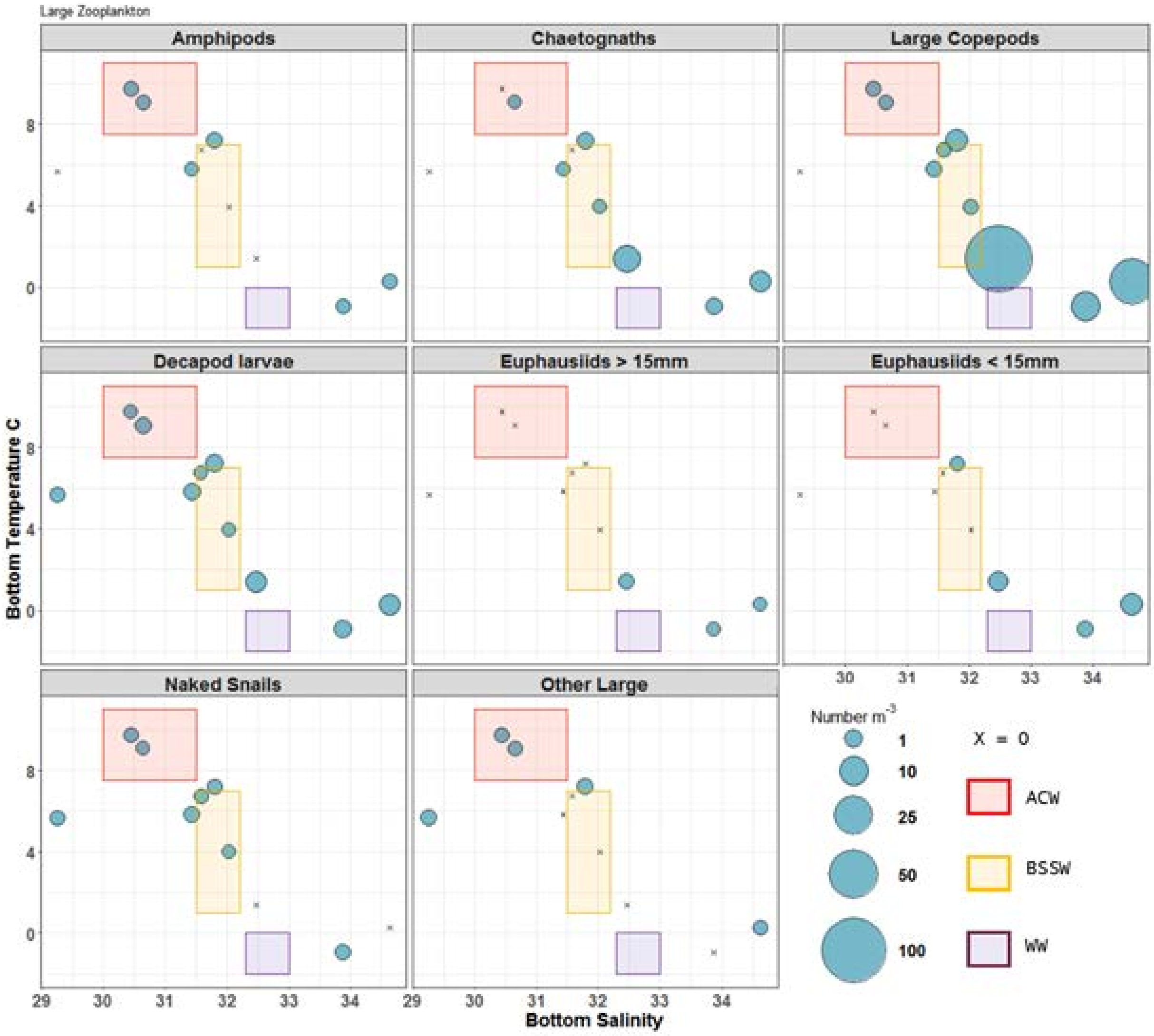


Fig. D2: Abundance of large zooplankton by temperature and salinity from Rapid Zooplankton Analysis on leg 1.

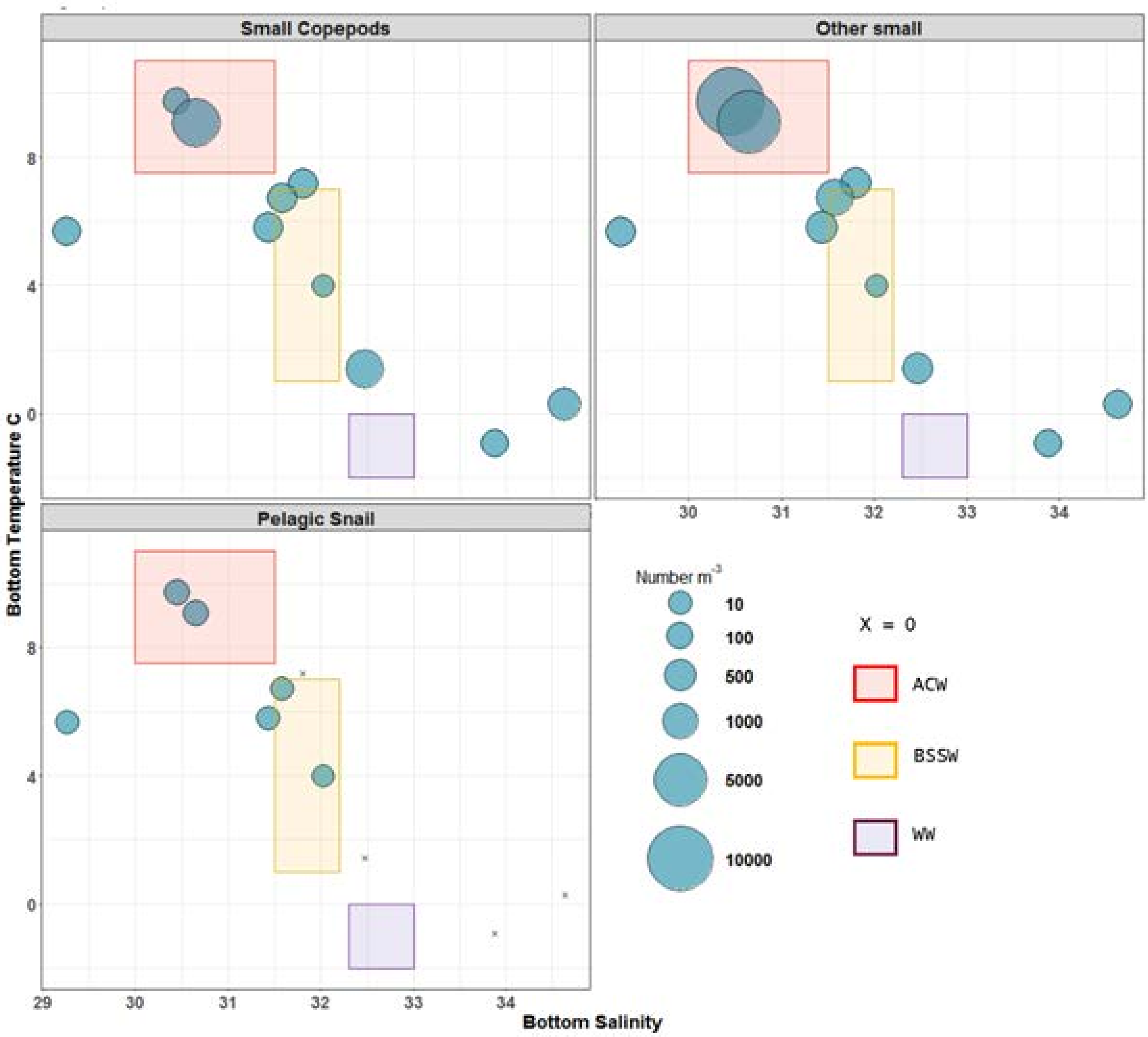


Fig. D3: Abundance of small zooplankton by temperature and salinity from Rapid Zooplankton Analysis on leg 1.

Ichthyoplankton

Larval fish were collected using a paired Bongo net frame mounted with two 60-cm diameter, 505 µm mesh nets and two 20-cm, 153 µm mesh nets that was towed in conjunction with a Seacat CTD profiler that recorded temperature and salinity (see above, *Zooplankton*). Quantitative samples were preserved in formalin from one side of the paired 60-cm net at each station for later enumeration and measuring at the Plankton Sorting and Identification Center in Poland. All fish from the other side of the 60-cm net were identified to the lowest taxonomic level possible and preserved for special projects. Four target species (*Limanda aspera*, *Mallotus villosus*, *Boreogadus saida*, and *Eleginus gracilis*) were frozen for stable isotope analyses. All other species were preserved in 95% ethanol for future studies. If fish of the target taxa were found in the non-quantitative 20 cm bongo net (net 2, 153 µm mesh), then they were also frozen for stable isotope analyses. Additionally, zooplankton from net 2 of the 505 µm and 153 µm nets were frozen from a subset of stations for stable isotope analyses.

A total of 93 fish were collected from Bongo nets, with 11 samples preserved in ethanol for future studies and the remainder frozen for stable isotope analyses. The most abundant taxon was *Boreogadus saida* (Table D1), particularly at higher latitude stations and with decreasing frequency towards the southern portion of the grid (Fig. D4). *Eleginus gracilis* were less common but were also collected at high latitude stations. *Mallotus villosus* were present closer to shore and in the northern portion of the grid, and *Limanda aspera* were encountered at lower latitude stations and were not present in the northern portion of the sample grid (Fig. D4). In addition to the four target taxa, five additional taxa were present (Table D1).

Table D1: Samples collected from Bongo nets that were either frozen for stable isotope studies or preserved in ethanol for future work. Gear refers to either 60 cm Bongo nets (505 µm mesh) or 20 cm Bongo nets (153 µm mesh). Zooplankton samples are frozen bulk samples for stable isotope work. All taxonomic identifications and preliminary and require additional verification.

Taxa	Gear	Count
Ammodytes hexapterus	60BON	6
Agonidae	60BON	4
Boreogadus saida	20BON	3
Boreogadus saida	60BON	25
Eleginus gracilis	60BON	6
Limanda aspera	20BON	2
Limanda aspera	60BON	6
Liparid	60BON	4
Mallotus villosus	60BON	6
Stichaeid	60BON	2
Unidentified *Boreogadus*	60BON	21
Unidentified *Mallotus*	60BON	6

Zoarcidae	60BON	2
Zooplankton	60BON	9
Zooplankton	20BON	31

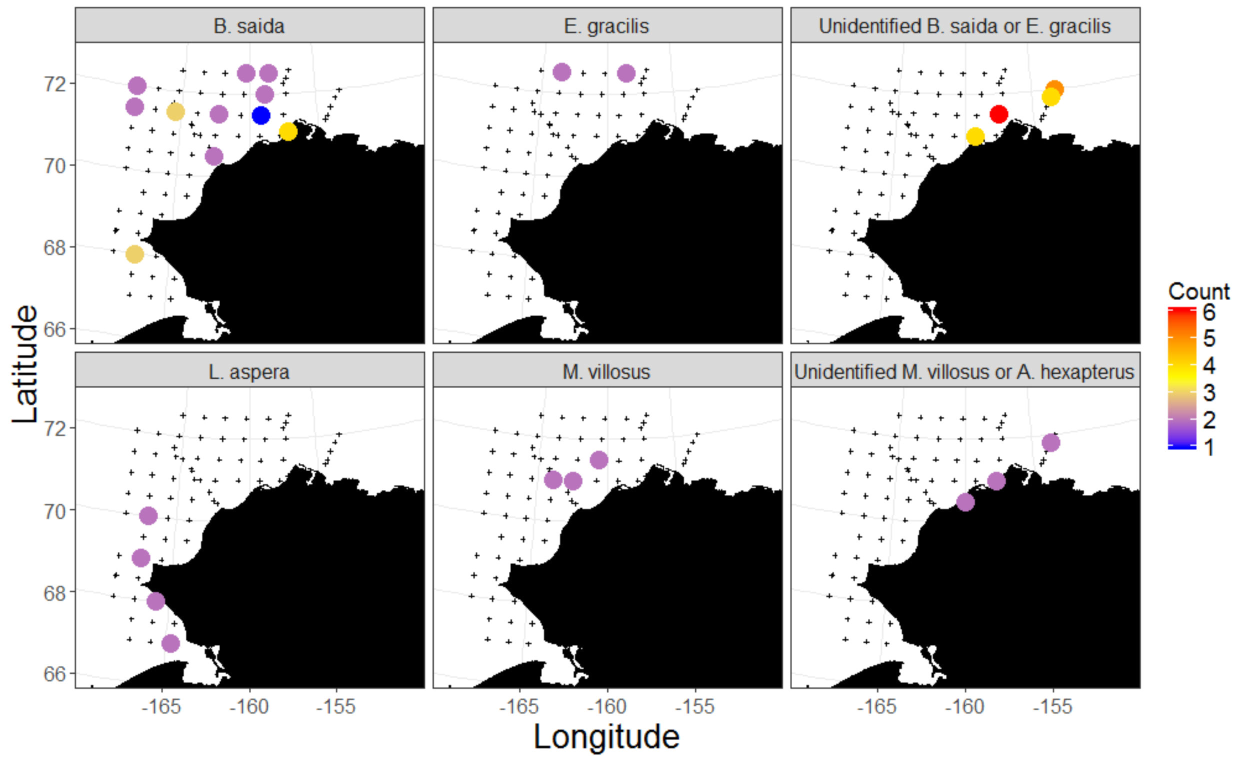


Fig. D4: Distribution of larval fish samples collected for stable isotope studies from four target species: *Boreogadus saida* (*B. saida*), *Eleginus gracilis* (*E. gracilis*), *Limanda aspera* (*L. aspera*), *Mallotus villlosus* (*M. villosus*). Color represents the number of individuals collected at each station and the black crosses are stations in which no fish were preserved.

E. FATTY ACIDS (Lisa Eisner, Ron Heintz, Louise Copeman, Johanna Vollenweider)

Fatty acid and total lipid samples were collected for zooplankton and seston (particles < 200 µm (microzooplankton, phytoplankton and detritus) at all grid stations sampled. Samples for zooplankton were kindly provided by Nissa Ferm, Dave Kimmel and Adam Spear (NOAA EcoFOCI) from vertical net tows. Large zooplankton (individuals), small zooplankton bulk samples and seston from water samples (filtered onto GFF filters) were stored frozen for later analysis of fatty acids and total lipids. This data will be used to determine what types of fatty acids (e.g. markers for different phytoplankton) are found in different water masses and if and where these fatty acids move up the food web to different zooplankton and larval fish species (samples collected in the surface and midwater trawls). Samples will be analyzed by the Alaska Fisheries Science Center, Juneau Alaska and at the Northwest Fisheries Science Center, Newport Oregon.

F. FISHING

Three types of trawls were used to sample Arctic fishes:

a) Surface Trawl to enumerate juvenile salmon
b) Midwater Trawl to groundtruth midwater acoustic targets
c) Bottom Trawl to describe benthic communities

Tests were completed during Leg 1 to optimize fishing performance of two pelagic trawls. The larger Nordic trawl was configured to fish only at the ocean surface, and the smaller Marinovich trawl was configured to fish in midwater. Additional setback was added to the larger Nordic trawl to increase the vertical mouth opening, and modifications were made to the trawl doors' V-rigging. As the smaller Marinovich midwater trawl was fished for the first time with rope bridles and the Nordic trawl X-Lite trawl doors, substantial efforts were made to determine the appropriate weight for the footrope to obtain the specified trawl mouth opening and to reduce the amount of trawl warp needed to get the trawl to the targeted depth.

G. DEMERSAL FISH AND INVERTEBRATES (Libby Logerwell, Dan Cooper)

Bottom Trawls

The 3m Plumb Staff Beam Trawl was deployed at 59 predetermined stations. One station was sampled in the Beaufort Sea, in relatively shallow water (25 m water depth). Epibenthic invertebrates dominated the catch, making up 94% of the total catch weight. The top 10 fish taxa caught (by biomass) were sculpins, Arctic Cod, pricklebacks, Bering Flounder, Yellowfin Sole, Walleye Pollock and Saffron Cod (Table G1). The Pollock were 10.3 – 16.7 cm in length and thus likely immature. The top 10 invertebrate taxa caught (by biomass) were brittlestars, Psolus sp. (Holothuroidea), Snow Crab, starfish, clams, sponges, and tubeworms. The Snow Crab were smaller than commercially-viable size, although ovigerous females were caught at two stations during Leg 2, CH-L01 and CH-L02 (71° 30.32' N 166° 57.34' W and 71° 30.19' N 168° 31.25' W, respectively). Figs. G1-G6 show the distribution of Arctic Cod, Saffron cod, Snow Crab, Walleye Pollock, and flatfish.

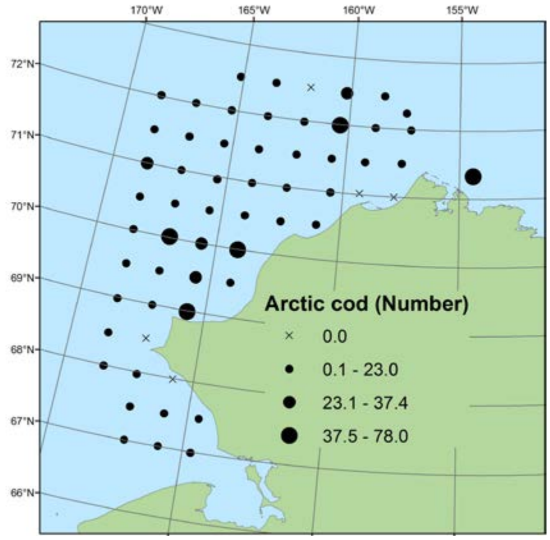


Fig. G1: Distribution of Arctic cod catch

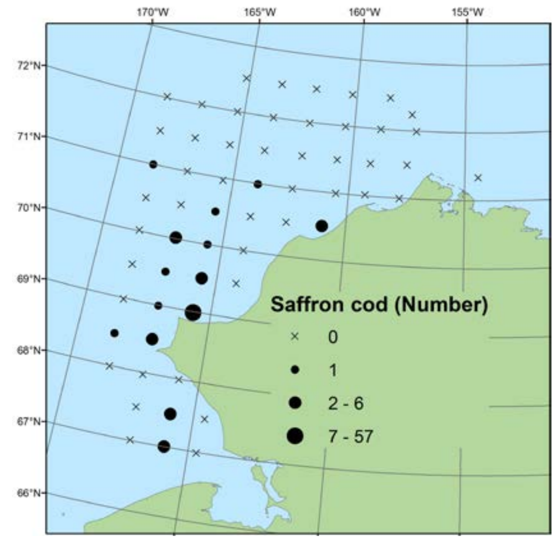


Fig. G2: Distribution of Saffron cod catch

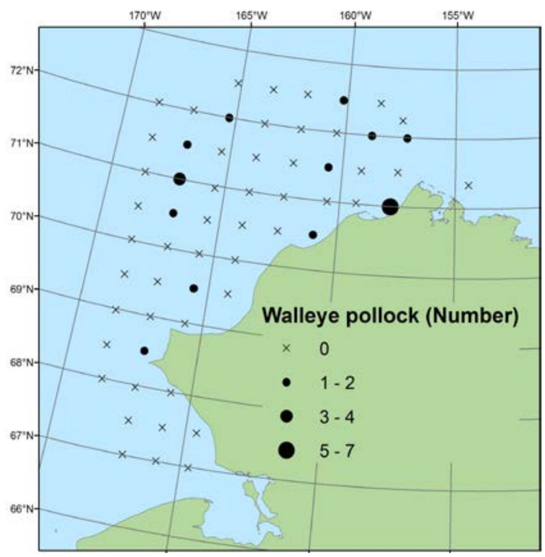


Fig. G3: Distribution of Walleye pollock catch

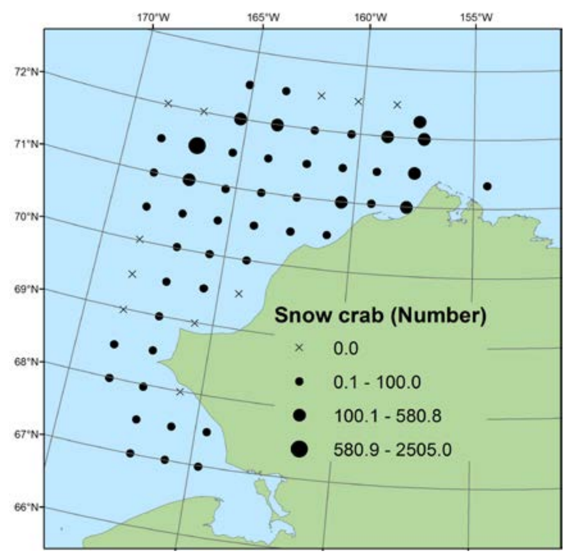


Fig. G4: Distribution of Snow crab catch

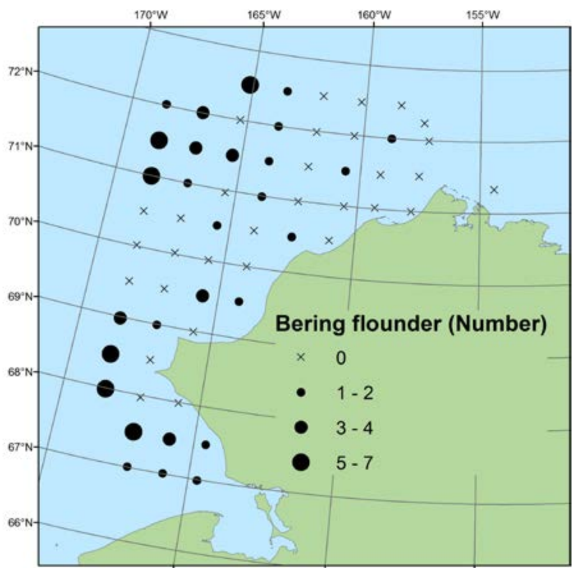


Fig. G5: Distribution of Bering flounder catch

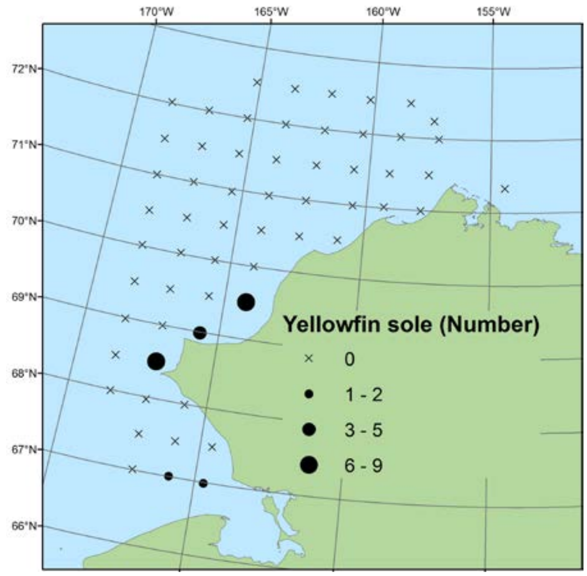


Fig. G6: Distribution of Yellowfin sole catch

Table G1: Preliminary numbers and weight (kg) of fishes (and snow crab) by species, common name, and Inupiat name caught in the 3m Plumb Staff Beam Trawl. Numbers and weight are "raw" catch and have not been standardized to distance traveled; some species identifications have yet to be confirmed.

Species	Common Name	Inupiaq Name	Weight (kg)	Number
Chionoecetes opilio	Snow crab		52.57	6145
Gymnocanthus tricuspis	Arctic staghorn sculpin	Kanayuq	1.87	456
Boreogadus saida	Arctic cod	Iqalugaq	1.74	803
Myoxocephalus scorpius	Shorthorn (Warty) sculpin	Kanayuq	1.45	456
Anisarchus medius	Stout eelblenny		0.94	271
Hippoglossoides robustus	Bering flounder		0.81	75

Lumpenus sagitta	Snake prickleback		0.66	297
Artediellus scaber	Hamecon	Kanayuq	0.46	197
Limanda aspera	Yellowfin sole		0.36	25
Gadus chalcogrammus	Walleye pollock		0.33	24
Eleginus gracilis	Saffron cod	Uugaq	0.25	92
Icelus spatula	Spatulate sculpin	Kanayuq	0.20	52
Lycodes polaris	Canadian eelpout		0.17	101
Stichaeus punctatus	Arctic shanny		0.11	37
Ammodytes	sand lance unid.		0.10	30
Lycodes mucosus	Saddled eelpout		0.10	15
Gadus macrocephalus	Pacific cod		0.09	26
Aspidophoroides olrikii	Arctic alligatorfish		0.08	102
Leptoclinus maculatus	Daubed shanny		0.07	16
Pleuronectiformes	Flatfish unident.		0.07	11
Triglops pingeli	Ribbed sculpin	Kanayuq	0.06	19
Gymnelus sp.		Kanayuq	0.05	17
Lumpenus sp.			0.05	86
Liparis sp.			0.05	80

Nautichthys pribilovius	Eyeshade sculpin	Kanayuq	0.05	15
Lycodes sp.			0.05	4
Lycodes polaris	Polar eelpout		0.05	8
Lycodes palearis	Wattled eelpout		0.04	27
Gymnelus hemifasciatus	Halfbarred pout		0.03	12
Mallotus villosus	Capelin	Panmagrak	0.03	9
Limanda proboscidea	Longhead dab		0.02	4
Eumesogrammus praecisus	Fourline snakeblenny		0.02	2
Hexagrammos stelleri	Whitespotted greenling		0.02	2
Gymnocanthus galeatus	Armorhead sculpin	Kanayuq	0.01	1
Gymnelus viridis	Fish doctor		0.01	1
Limanda sakhalinensis	Sakhalin sole		0.01	1
Myoxocephalus polyacanthocephalus	Great sculpin	Kanayuq	0.01	7
Clupea pallasii	Pacific herring	Uqsruqtuuq	0.01	1
Icelus bicornis	Two Horn Sculpin	Kanayuq	0.01	1
Cottidae	Sculpin unident.	Kanayuq	0.01	21
Myoxocephalus sp.		Kanayuq	0.003	2

Ammodytes hexapterus	Arctic Sand Lance		0.002	1
Hypsagonus quadricornis	Fourhorn poacher		0.002	2
Podothecus veternus	Veteran poacher		0.002	2
Icelus sp.		Kanayuq	0.001	1
Liparis gibbus	Variegated snailfish		0.001	2

H. MIDWATER FISHES/ACOUSTICS (Robert Levine, Alex De Robertis, Chris Wilson)

Active Acoustics

Acoustic data were collected using a Simrad EK60 scientific echosounder operating at 38 and 120 kHz during the the survey. Acoustic backscatter was detected along much of the survey trackline. Vertical distribution was variable, ranging from within the upper 20 m of the ocean surface to near the seafloor depending on location. A separate deep backscatter layer was observed off the shelf in the North Chukchi and Beaufort Seas. However, this layer was never sampled due to vessel limitations. The greatest intensity of acoustic backscatter was found in the Chukchi Sea between 70 and 71.5 °N in areas where age-0 arctic cod were captured in midwater trawls (see Table H1 below). Most of the backscatter was attributed to age-0 Arctic cod. Preliminary results suggest that acoustic backscatter from Arctic cod was greater and more widespread in 2017 than in the earlier 2012 and 2013 surveys.

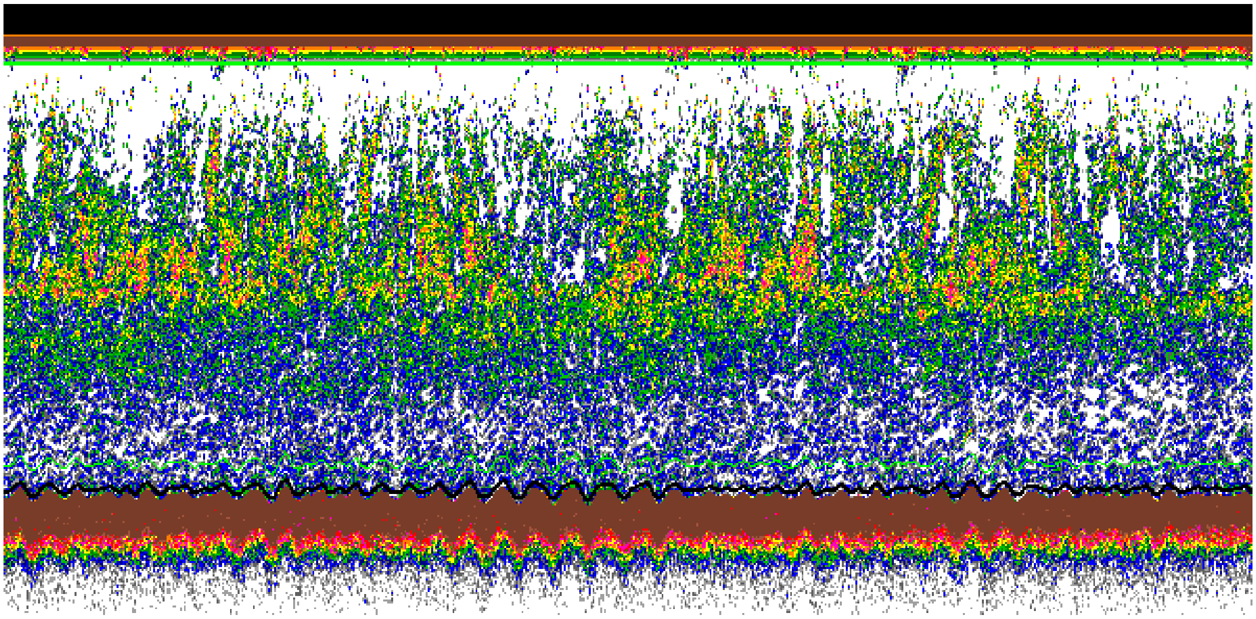


Fig. H1: Water column backscatter along a transect in the North Chukchi Sea. A midwater trawl conducted in the vicinity (20 minutes duration at 1.8 kts) caught 8,544 age-0 Arctic cod, 36 jellyfish, 13 pricklebacks and 1 sculpin.

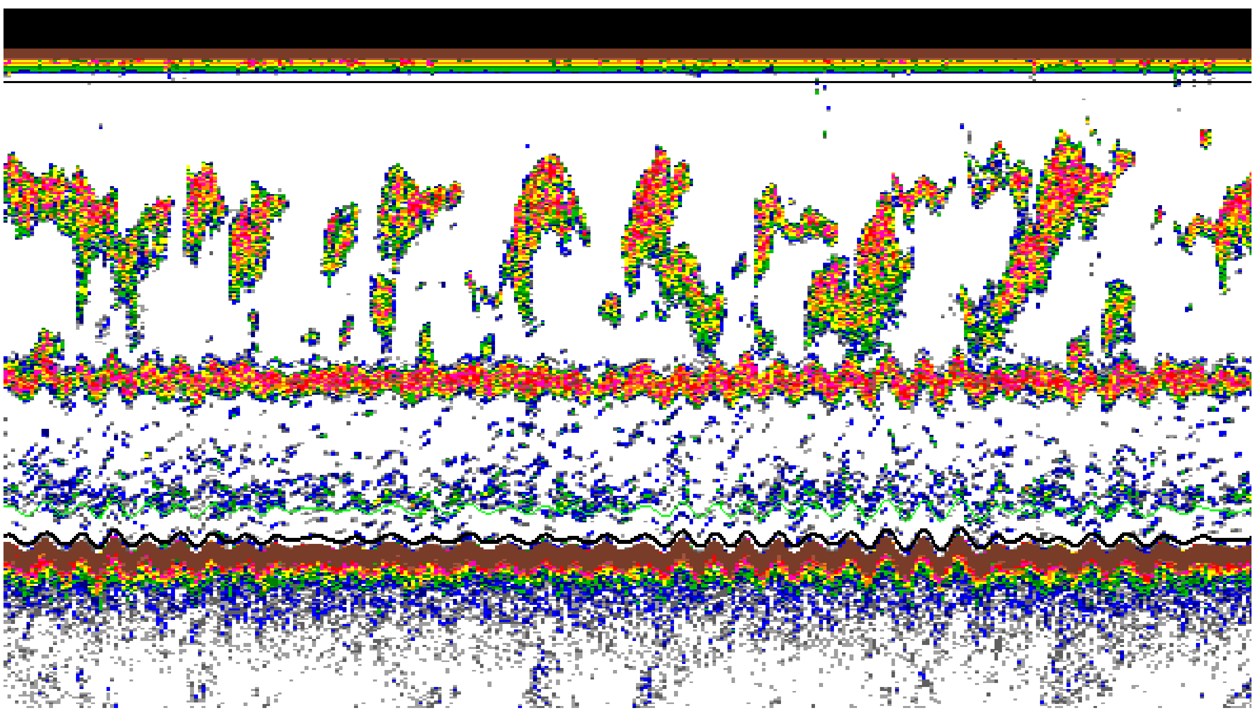


Fig. H2: Water column backscatter along a transect in the Central Chukchi Sea. A midwater trawl conducted in the vicinity (20 minutes duration at 2.2 kts) caught 18,517 age-0 Arctic cod, 3,146 pricklebacks, 740 sand lance, 520 capelin, and 54 jellyfish (5 other species represented the remaining catch of 50 individuals). Age-0 Arctic cod and jellyfish comprised 33% and 51% of the catch by weight, respectively.

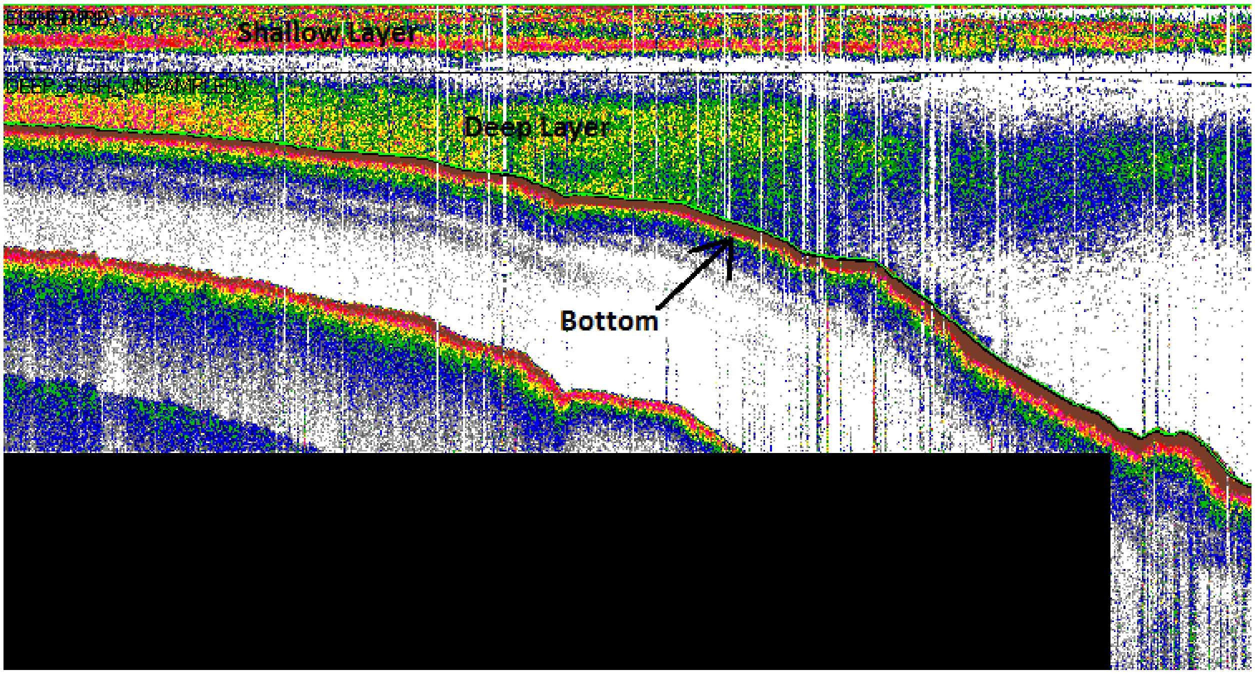


Fig. H3: Acoustic backscatter in deep water of the Beaufort shelfbreak. A distinct deep scattering layer occurred at depth of approx. 100 m and persisted into deep water. Net sampling at the depth of the layer was not possible due to vessel constraints.

Midwater Trawl Hauls

A twice modified Marinovich trawl (hereafter mod2-Marinovich) with a 2x3 mm hexagonal codend liner was deployed with 3m X-Lite trawl doors for midwater sampling. Nine fine-mesh (2x3 mm) recapture (pocket) nets were attached to the outside of the trawl to quantify escapement. A total of 33 midwater trawl hauls were conducted throughout the survey area to characterize the backscatter along the survey trackline. Two of these hauls were conducted in the Beaufort Sea. The net opening was approximately 8.2 m vertically by 7.5 m horizontally for all hauls. The average headrope depth ranged from 11.4m to 46.8 m, and average vessel trawling speed was 2.2 knots.

Age-0 Arctic cod was the dominant species captured. This species was present throughout the entire survey area, and accounted for 91.5% of the total catch by numbers and 14.6% by weight based on all midwater trawl hauls (Table H1). The average number of age-0 Arctic cod in each trawl haul was 13,364 (range 16 to ~34,300). The mean fork length of Arctic cod in the trawl catches ranged from 32 to 62 mm.

Euphausiids (3.2%), capelin (1.3%), and various stichaeids (1.1%) were the next most abundant species after age-0 Arctic cod. Jellyfish dominated the catch by weight with *Chrysaora melanaster* contributing 51.2% and *Cyanea* spp. contributing 29.9%. Saffron cod and Pacific cod increased in abundance in the southern area of the survey and in midwater trawl hauls near Kotzebue Sound, but only accounted for 0.12% and 0.02% of the catch by weight, respectively (Table H1).

<u>Table H1</u>: Preliminary numbers and weight (kg) of fishes and invertebrates by species, common name, and Inupiat name caught in the midwater trawl. Numbers and weight are "raw" catch and have not been standardized to distance traveled.

Species	**Common Name**	**Inupiaq Name**	**Weight (kg)**	**Number**
Aequorea sp.	Aequorea jellyfish		1.881	8.7692
Amphipoda	Amphipod		0.2416	677.6622
Aspidophoroides olrikii	Arctic alligatorfish		0.0159	37.4281
Boreogadus saida	Arctic cod	Iqalugaq	312.950	441011.9
Gymnocanthus tricuspis	Arctic staghorn sculpin	Kanayuq	0.3408	417.9049
Aurelia sp.	Aurelia jellyfish		11.793	246.8183
Anarhichas orientalis	Bering wolffish		0.006	1
Mallotus villosus	Capelin	Panmagrak	17.2446	6093.834
Chrysaora melanaster	Chrysaora jellyfish		1094.35	1193.074
Neocrangon sp.	Crangon shrimp		0.0267	51.4937
Blepsias bilobus	Crested sculpin	Kanayuq	0.038	3
Crustacea sp.	Crustacean larvae		0.001	2
Leptoclinus maculatus	Daubed shanny		0.0373	43.7108
Eualas gaimardi gaimardi	Circumpolar eualid		0.001	1
Euphausiacea	Euphausiid (unidentified)		1.5728	15699.61
Bugula plumosa	Feathery bryozoan		0.001	1
Fish larvae (unidentified)			0.0122	17.7432
Flatfish larvae (unidentified)			0.001	1
Gonatus kamtschaticus	Gonate squid		0.281	26
Pandalus borealis	Greenland shrimp		0.001	2
Reinhardtius hippoglossoides	Greenland turbot		0.008	1
Artediellus scaber	Hamecon	Kanayuq	0.9996	2187.677
Jellyfish (Unidentified)			0.9015	152.7342
Arguis lar	Kuro argid		0.002	1
Agonidae sp.	Poacher (unidentified)		0.0048	4.8261
Cyanea capillata	Lions mane jellyfish		640.882	1550.522
Limanda proboscidea	Longhead dab	Nataagnaq	0.002	2

Lumpenus sp.	Pricklebacks		8.6882	9289.534
Mysidae	Mysid shrimp		0.0149	14.9032
Gadus macrocephalus	Pacific cod		0.3482	128.4805
Pandalus sp.	Pandalus shrimp		0.0086	8.6054
Eleginus gracilis	Saffron cod	Uugaq	2.6489	1018.634
Cottidae	Sculpin (unidentified)	Kanayuq	0.002	4
Echinocardium cordatum	Sea potato		0.069	2
Myoxocephalus scorpius	Shorthorn sculpin	Kanayuq	1.5436	81.6176
Shrimp (unidentified)			0.0086	25.8161
Lumpenus fabricii	Slender eelblenny		0.0914	207.5352
Liparis sp.	Snailfish (unidentified)		0.0338	56.9424
Icelus spatula	Spatulate sculpin	Kanayuq	0.001	2
Gonatus sp.	Squid (unidentified)		0.005	2
Staurophora mertensi	Whitecross jellyfish		0.007	2
Anisarchus medius	Stout eelblenny		0.0149	34.1289
Podothecus veternus	Veteran poacher		0.001	1
Gadus chalcogrammus	Walleye pollock		0.002	1
Aurelia limbata	Brown rimmed jellyfish		39.423	445.9633
Ammodytes sp.	Sandlance	Panmaksraq	1.9239	1447.808

I. SURFACE FISHES (Ed Farley, Kristin Cieciel, and Johanna Vollenweider)

The 264 Nordic Rope Trawl with 3m X-Lite doors was deployed for half-hour tows at 17 pre-determined nearshore stations. One haul was in the Beaufort Sea and sixteen hauls in the Chukchi Sea. The most numerous organisms caught in the surface trawl included jellyfish (34%) that included cyanea and *Chrysaora melanaster*, gadids (32%) of which age-0 Arctic cod dominated, cottids (17%) which were mostly staghorn sculpin, and osmerids (10%) made up of capelin (Table I1). Species caught in much smaller numbers (<3%) included Pacific Sand lance, Pacific Herring, and Walleye Pollock. By weight, jellyfish dominated the catch (99%), and was comprised of *Cyanea* (61%) and *Chrysaora melanaster* Jellyfish (38%). One juvenile pink salmon was captured in the surface trawl near Kotzebue Sound.

Table I1: Preliminary numbers and weight (kg) of fishes by species, common name, and Inupiat name caught in the Nordic 264 surface trawl. Numbers and weight are "raw" catch and have not been standardized to net opening or distance traveled.

Family	Species	Common Name	Inupiat Name	Number	Weight
Aequoreidae	Aequorea sp.	Jellyfish		12	3.026
Ammodytidae	Ammodytes	Sandlance	Panmaksraq	89	0.075
Anarhichadidae	Anarhichas	Bering wolffish		6	0.143
Clupeidae	Clupea pallasii	Pacific herring	Uqsruqtuuq	51	1.18
Cottidae	Artediellus scaber	Hamecon		24	0.033
	Myoxocephalus	Shorthorn sculpin	Kanayuq	521	1.094
Cyaneidae	Cyanea capillata	Jellyfish		667	407.806
Cyclopteridae	Eumicrotremus	Pimpled		1	0.03
Gadidae	Boreogadus saida	Arctic cod/	Iqalugaq	937	0.653
	Gadus	Pacific cod		57	0.194
	Eleginus gracilis	Saffron	Uugaq	36	0.134
	Gadus	Walleye pollock		1	0.026
Gonatidae	Gonatus	Squid		3	0.042
	Gonatus sp.	Squid		5	0.036
Haloclavidae	Peachia	Anemone		10	0.002
Hemitripteridae	Blepsias bilobus	Crested sculpin	Kanayuk	1	0.126
	Jellyfish (unid)	Jellyfish		16	0.071
Laodiceidae	Staurophora	Jellyfish		1	0.026
Liparidae	Liparis gibbus	Variegated		1	0.012
Osmeridae	Mallotus	Pacific capelin	Panmaksraq	317	1.294
Pelagiidae	Chrysaora	Jellyfish		400	254.697
Pleuronectidae	Flatfish unid.			1	0.001

	Limanda	Longhead dab	Nataagnaq	31	0.012
	Platichthys	Starry flounder	Nataagnaq	1	0.232
	Limanda aspera	Yellowfin sole		1	0.065
Salmonidae	Onchorynchus	Pink salmon	Amaqtuuq	1	0.041
Stichaeidae	Lumpenus sp.			4	0.001
	Lumpenus fabricii	Slender eelblenny		22	0.003
	Lumpenus sagitta	Snake prickleback		2	0.001
Zaproridae	Zaprora silenus	Prowfish		1	0.116

J. JELLYFISH (Kristin Cieciel)

Macro jellyfish were sampled through the three types of trawl gear, the Nordic 264, Marinovich and 3m Beam. The most abundant species by weight for all gear (combined catch weights of all three trawls) was *Chrysaora melanaster* at 54% of the total jellyfish catch followed by *Cyanea capillata* at 42%, and *Aurelia labiata* at 3%. Species in low numbers but still present were noted for *Aequorea sp*., *Staurophora mertensii*, *Aurelia sp*. and one species of unidentified Ctenophore, these combined made up less than 1% of the total jellyfish catch. Noticeable differences between gear were seen with the beam trawl which was only catching jellies in small numbers during deployment and retrieval but it managed to sample all major species. Differences were also noted between areas, Leg 1 Chukchi/Beaufort and Leg 3 Southern Chukchi had higher catches for *Cyanea capillata* than Leg 2 Northern Chukchi which had higher catches of *Chrysaora melanaster* because survey areas, trawling types, and sample numbers varied greatly it is difficult to conclude anything other than what is currently stated for preliminary reporting.

Dipnetting of jellyfish occurred over all three legs but only two successful sampling events occurred over the 63 days of survey. Leg 1 had one location were 3 species were netted and Leg 3 had one location on the last day of sampling where 10 samples were collected. The major reason for the lack of jellyfish samples through dipnetting was due to wind. Wind presence over 15kn makes it difficult view just below the surface of the water and also makes it difficult to physically catch animals by putting a 14 foot net over the side. The 13 samples of various gelatinous species were preserved and will be worked up for diets.

K. MARINE BIRDS AND MARINE MAMMALS (Kathy Kuletz, Liz Labunski, Marty Reedy)

At-Sea Observers: Marty Reedy (Legs 1 & 2), Terry Doyle and Zak Pohlen (Leg 3)
Principal Investigator: Kathy Kuletz
Maps and data summaries: Elizabeth Labunski
U.S. Fish & Wildlife Service, Migratory Bird Management
1011 E. Tudor Rd., Anchorage, Alaska 99503

Background

Marine bird surveys were conducted by U.S. Fish and Wildlife Service (USFWS) observers, with support to USFWS via an Interagency Agreement with the Bureau of Ocean Energy Management (M17PG00017) for project AK-16-07C: Seabird Community Structure and Seabird-Prey Dynamics. This study examines the distribution of marine birds relative to prey and oceanographic properties, and timing of use by marine birds in the Beaufort and Chukchi Planning Areas. Marine bird surveys were conducted while the ship was underway from Dutch Harbor on August 1 until the end of the cruise in Nome on October 4. In this report we summarize data collected during all three legs of the ArcticIERP project. Marine bird and mammal data from these surveys will be uploaded to the ArcticIERP workspace and archived in the North Pacific Pelagic Seabird Database (http://alaska.usgs.gov/science/biology/nppsd).

Methods

Marine birds and mammals were surveyed from the starboard side of the bridge using standard USFWS protocols, during daylight hours while the vessel was underway. The observer scanned the water ahead of the ship using hand-held 10x 42 binoculars if necessary for identification and recorded all birds and mammals within a 300-m arc extending 90˚ from the bow to the beam. We used strip transect methodology and four distance bins extending from the vessel: 0-50 m, 51-100 m, 101-200 m, and 201-300 m and recorded the animal's behavior (flying, on water, foraging). Rare birds, large flocks, and mammals beyond 300 m or on the port side (off-transect) were also recorded but will not be included in density calculations. Birds on the water or actively foraging were counted continuously. Flying birds were recorded during quick 'Scans' of the transect window (typically every 65 or 97 seconds), at intervals based on ship speed. Observations were entered directly into a GPS-integrated laptop computer using the program DLOG3 (A.G. Ford Consultants, Portland, OR). Location data was also recorded automatically at 20 sec intervals, providing continuous records on weather, Beaufort Sea State, ice coverage, glare, and observation conditions. In addition, during this cruise the data management system CLAMS was used by the science crew to log of sampling events for future reference. Seabird surveys were entered into the system by recording the start and end points of the survey effort while the vessel was underway.

Preliminary Results and Discussion

We surveyed a total of 6,565 km from Aug 1 – Oct 4, 2017 during which we recorded a total of 37,465 birds on-transect (Table K1) in the Bering and Chukchi Sea. A small number of transects (totaling 242 km) were surveyed in the western-most portion of the Beaufort Sea, which for this report are combined with Chukchi Sea observations. The breakdown of survey effort by cruise leg was 2,759 km, 2,217 km, 1,579 km, legs 1 – 3, respectively. By Region we surveyed 1,670 km in the Bering Sea and recorded 9,808 birds of 38 identified marine bird species. In the Chukchi (and western Beaufort) we surveyed a total of 6,565 km and recorded 27,657 birds of 29 marine bird species, on-transect (within the 300 m transect window). Although surveys were conducted across the Bering and Chukchi seas, the summaries below focus on seabirds observed in the core ArcticIERP study area in the Chukchi Sea.

Short-tailed shearwater (*Ardenna tenuirostris*) was the most commonly observed species during the survey and comprised 65.6 % of total observations in the Chukchi Sea (Table K1). Shearwaters were widely distributed across the survey area, with highest densities in offshore areas north of Icy Cape (Fig. K1), although they were largely absent north of 72°N. Shearwater densities observed during earlier 2017 surveys indicate that this species started moving into the study area in late June and increased and moved north in July and August. Only a few shearwaters were observed in the Chukchi Sea during the last days of the ASGARD cruise, which ended June 29, and numbers observed during the July AMBON cruise were a magnitude lower than those observed during ArcticIERP. In addition to much higher densities in August and September, shearwaters were farther north than during earlier surveys.

Three species of auklets, crested auklets (*Aethia cristatella),* least auklets (*A. pusilla),* and parakeet auklets (*A. psittacula*) comprised a total of 15.5 % of the total observations in the Chukchi (Table K1). Crested auklets were the most prevalent and comprised 90 % of identified auklets. The highest densities of crested auklets were north of 71°N in the northwestern part of the study area (Fig. K2). Much smaller numbers of least auklets were recorded in this area. Parakeet auklets were mainly in the southern Chukchi Sea near Point Hope.

Black-legged kittiwakes (*Rissa tridactyla)* were the third most commonly observed species during the survey, comprising 5.2 % of total birds (Table K1). Kittiwakes were primarily in the southern Chukchi Sea, with particularly high densities from offshore of Point Hope to northwest of Cape Lisburne, in the vicinity of breeding colonies (Fig. K3.) Glaucous gulls (*Larus hyperboreus)* were more widely distributed and in much lower numbers. We observed a concentration of Sabine's gulls (*Xema sabini*) and Arctic terns (*Sterna paradisaea*) along Barrow Canyon (Fig. K3); both species are surface feeders and similar in their diets of small fish and crustaceans.

Murres (*Uria spp*.) represented 4.9 % of total observations, with thick-billed murres (*U. lomivia*) comprising most of the identified murres (Table K1). Thick-billed murres were distributed across the study area south of 72°N with highest densities in offshore waters northwest of Cape Lisburne, near breeding colonies (Fig. K4). Common murres (*U. aalge*) had a similar distribution but in much lower densities.

Phalaropes (*Phalaropus spp.*) were patchily distributed across the study area and comprised 3.4 % of total observations (Table K1). Nearly all identified phalaropes were red phalaropes (*P. fulicarius*), but as most birds were molting it was difficult to distinguish red from red-necked (*P. lobatus*) phalaropes. Phalaropes were concentrated along Barrow Canyon and in offshore waters northwest of Icy Cape and Wainwright (Fig. K5). In the southern Chukchi Sea, phalaropes were mainly observed near Point Hope.

Seaducks tend to be nearshore, thus our offshore surveys don't capture the high densities along Chukchi coasts, and observations comprised < 0.6 % of total birds (Table K1). Most observations of seaducks were recorded off transect > 300 m from the vessel (Fig. K6). There was an aggregation, including off transect birds, of king eiders (*Somateria spectabillis*) near Icy Cape and spectacled eiders (*S. fischeri*) just outside Ledyard Bay (Fig. K6). Long-tailed duck (*Clangula hyemalis*) was the most abundant seaduck, particularly near Point Hope (Fig. K6).

We recorded three species of loons (*Gavia spp*.), with Pacific loon (*G. pacifica*) the most commonly identified species (Table K1). Loons were generally observed close to shore from Wainwright south to 67°N (Fig. K7). The numbers of loons observed during this ArcticIERP cruise was higher than normally encountered during offshore surveys in the Chukchi Sea.

We recorded marine mammals but because our survey protocol was for marine birds these observations cannot be used to calculate standard marine mammal densities. We recorded a total of 204 marine mammals on transect (within 300 m) and off transect (> 300 m or on port side of vessel) during surveys in the Bering and Chukchi seas (Table K2). Walrus was the most abundant marine mammal observed, with the majority concentrated offshore between Icy Cape and Wainwright (Fig. K8). Cetaceans were recorded in small numbers, with most Gray whales offshore of Wainwright (Fig. K9). Farther south, small groups of cetaceans were in offshore waters of the DBO3 line extending off Point Hope and south towards Bering Strait. In addition, we recorded two deceased marine mammals; these could not be positively identified, but one appeared to be a pinniped and the other a whale. We submitted a report about the dead animals to Marine Mammal Stranding Network/NOAA, Juneau, AK.

Table K1. Birds recorded on-transect during 2017 ArcticIERP Marine Bird Surveys, August 1 – October 4.

		Bering		Chukchi		
Common Name	Scientific Name	No.	% Total	No.	% Total	Total
Common Loon	*Gavia immer*			2	0.01	2
Pacific Loon	*Gavia pacifica*	34	0.35	54	0.20	88
Red-throated Loon	*Gavia stellata*	2	0.02			2
Yellow-billed Loon	*Gavia adamsii*	1	0.01	1	0.00	2
Unid. Loon	*Gavia spp.*	16	0.16	10	0.04	26
Black-footed Albatross	*Phoebastria nigripes*	6	0.06			6
Laysan Albatross	*Phoebastria immutabilis*	20	0.20			20
Northern Fulmar	*Fulmarus glacialis*	1885	19.22	507	1.83	2392
Short-tailed Shearwater	*Ardenna tenuirostri*	1564	15.95	18141	65.57	19705
Unid. Dark Shearwater	*Ardenna spp.*	3297	33.62	5	0.02	3302
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	167	1.70	8	0.03	175
Unid. Procellariiformes	*Procellarid spp.*	8	0.08	2	0.01	10
Pelagic Cormorant	*Phalacrocorax pelagicus*	30	0.31	12	0.04	42
Red-faced Cormorant	*Phalacrocorax urile*	2	0.02			2
Cackling Canada Goose	*Branta hutchinsii*	1	0.01			1
Common Eider	*Somateria mollissima*			18	0.07	18
Harlequin Duck	*Histrionicus histrionicus*	4	0.04			4
King Eider	*Somateria spectabilis*	3	0.03	1	0.00	4
Long-tailed Duck	*Clangula hyemalis*	1	0.01	76	0.27	77
Spectacled Eider	*Somateria fischeri*			50	0.18	50
White-winged Scoter	*Melanitta fusca*	22	0.22			22
Unid. Eider	*Somateria spp.*	4	0.04	20	0.07	24
Unid. Duck	*Anatinae spp.*			2	0.01	2
Bald Eagle	*Haliaeetus leucocephalus*	1	0.01			1
Red Phalarope	*Phalaropus fulicarius*	41	0.42	215	0.78	256
Red-necked Phalarope	*Phalaropus lobatus*	1	0.01			1
Unid. Phalarope	*Phalaropus spp.*	102	1.04	716	2.59	818
Unid. Shorebird	*Scolopacidae spp.*	1	0.01	6	0.02	7
Long-tailed Jaeger	*Stercorarius longicaudus*	3	0.03	1	0.00	4
Parasitic Jaeger	*Stercorarius parasiticus*	4	0.04	15	0.05	19
Pomarine Jaeger	*Stercorarius pomarinus*	14	0.14	36	0.13	50
Unid. Jaeger	*Stercorarius spp.*	1	0.01	10	0.04	11
Arctic Tern	*Sterna paradisaea*	1	0.01	56	0.20	57
Unid. Tern	*Sterna spp.*			23	0.08	23
Black-legged Kittiwake	*Rissa tridactyla*	1029	10.49	1432	5.18	2461
Glaucous Gull	*Larus hyperboreus*	67	0.68	100	0.36	167
Glaucous-winged Gull	*Larus glaucescens*	149	1.52	1	0.00	150
Herring Gull	*Larus argentatus*	1	0.01			1
Red-legged Kittiwake	*Rissa brevirostris*	13	0.13			13
Unid. Kittiwake	*Rissa spp.*	6	0.06			6
Sabine's Gull	*Xema sabini*			39	0.14	39
Unid. Gull	*Larid spp.*	5	0.05	8	0.03	13
Common Murre	*Uria aalge*	136	1.39	248	0.90	384
Thick-billed Murre	*Uria lomvia*	199	2.03	973	3.52	1172

Table K1 Continued. Birds recorded on-transect during 2017 ArcticIERP Surveys.

		Bering		Chukchi		
Common Name	Scientific Name	No.	% Total	No.	% Total	Total
Unidentified Murre	*Uria spp.*	57	0.58	123	0.44	180
Pigeon Guillemot	*Cepphus columba*	16	0.16			16
Ancient Murrelet	*Synthliboramphus antiquus*	88	0.90	188	0.68	276
Brachyramphus Murrelet	*Brachyramphus spp.*	4	0.04			4
Kittlitz's Murrelet	*Brachyramphus brevirostris*			22	0.08	22
Marbled Murrelet	*Brachyramphus marmoratus*	5	0.05			5
Cassin's Auklet	*Ptychoramphus aleuticus*	24	0.24			24
Crested Auklet	*Aethia cristatella*	67	0.68	3859	13.95	3926
Least Auklet	*Aethia pusilla*	88	0.90	299	1.08	387
Parakeet Auklet	*Aethia psittacula*	92	0.94	137	0.50	229
Unid. Auklet	*Aethiia spp.*	14	0.14	72	0.26	86
Horned Puffin	*Fratercula corniculata*	278	2.83	78	0.28	356
Tufted Puffin	*Fratercula cirrhata*	197	2.01	32	0.12	229
Unid. Puffin	*Fratercula spp.*	1	0.01			1
Unid. Alcid	*Alcid spp.*	36	0.37	52	0.19	88
Passerine spp.	*Passeriformes spp.*			2	0.01	2
Unid. Bird	*Aves spp.*			5	0.02	5
		9808		27657		37465

Table K2: Marine Mammals observed during 2017 ArcticIERP Marine Bird Surveys. 'On' transect observations were within the 300 m transect window on starboard side of the vessel. 'Off' transect observations were beyond the 300 m window or on the port side of the vessel.

		Bering		Chukchi		
Common Name	Scientific Name	On	Off	On	Off	Total
Dall's Porpoise	*Phocoenoides dalli*	5				5
Harbor Porpoise	*Phocoena phocoena*			4	3	7
Harbor Seal	*Phoca vitulina*	1				1
Northern Fur Seal	*Callorhinus ursinus*	6				6
Unidentified Seal	*Phocidae spp.*	3		6	3	12
Walrus	*Odobenus rosmarus*			17	28	45
Unidentified Pinniped	*Pinnipedia spp.*			7		7
Fin Whale	*Balaenoptera physalus*		2	1	2	5
Gray Whale	*Eschrichtius robustus*			3	16	19
Humpback Whale	*Megaptera novaeangliae*	1	2	1	6	10
Killer Whale	*Orcinus orca*		5			5
Minke Whale	*Balaenoptera acutorostrata*	2	2			4
Unidentified Whale	*Cetacea spp.*		3	5	70	78

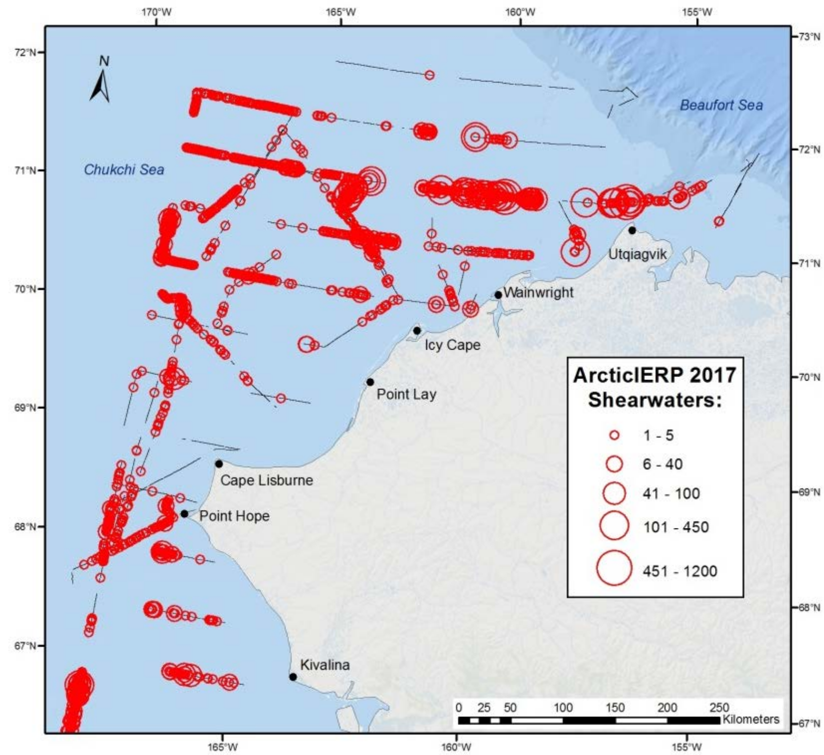


Figure K1: Distribution of shearwaters observed on transect during ArcticIERP 2017. Black lines indicate Marine Bird Survey transects.

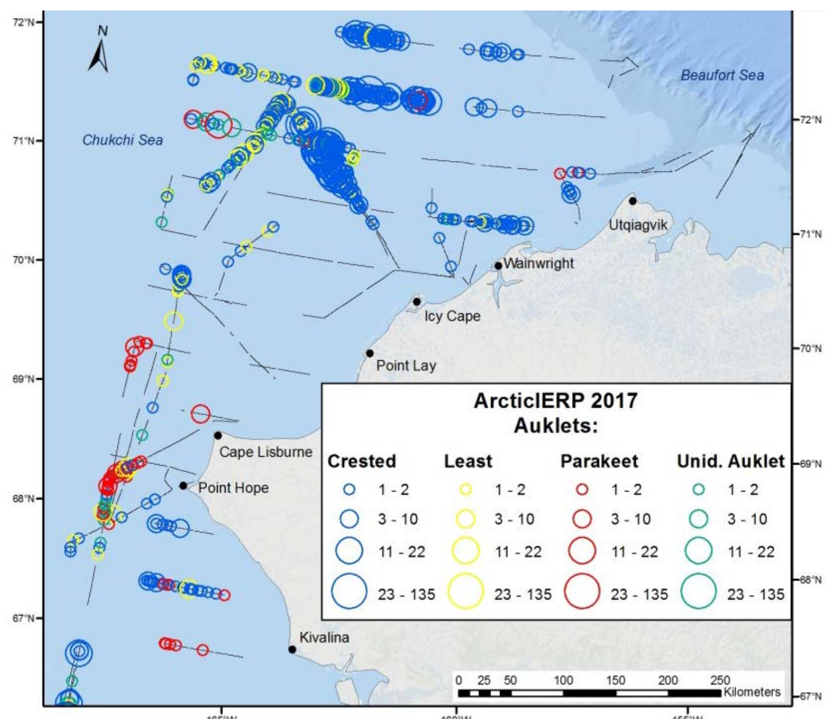


Figure K2: Auklets were widely distributed in the survey area with high concentrations of crested auklets in the northwest part of the study area.

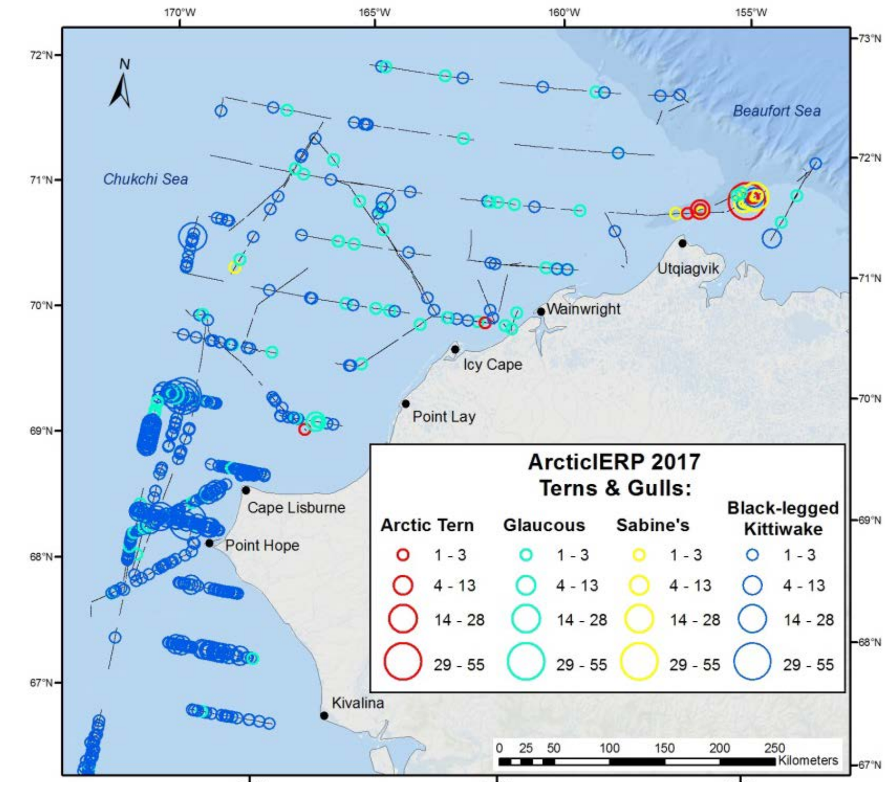


Figure K3: Distribution of terns and gulls observed on transect during ArcticIERP 2017.

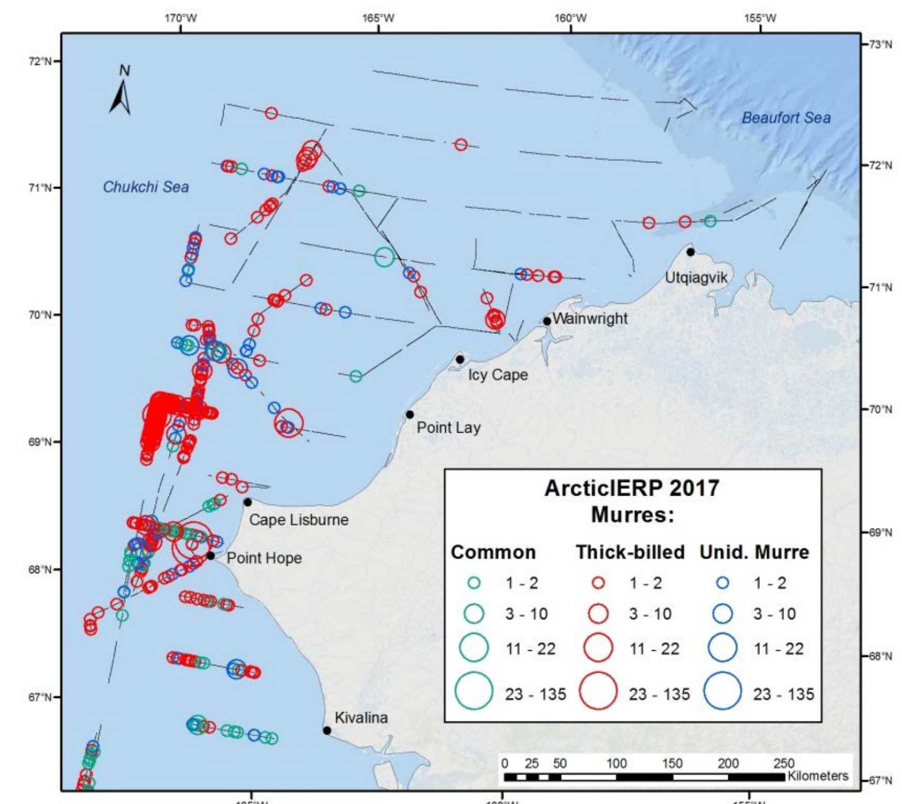


Figure K4: Distribution of murres observed on transect during ArcticIERP 2017.

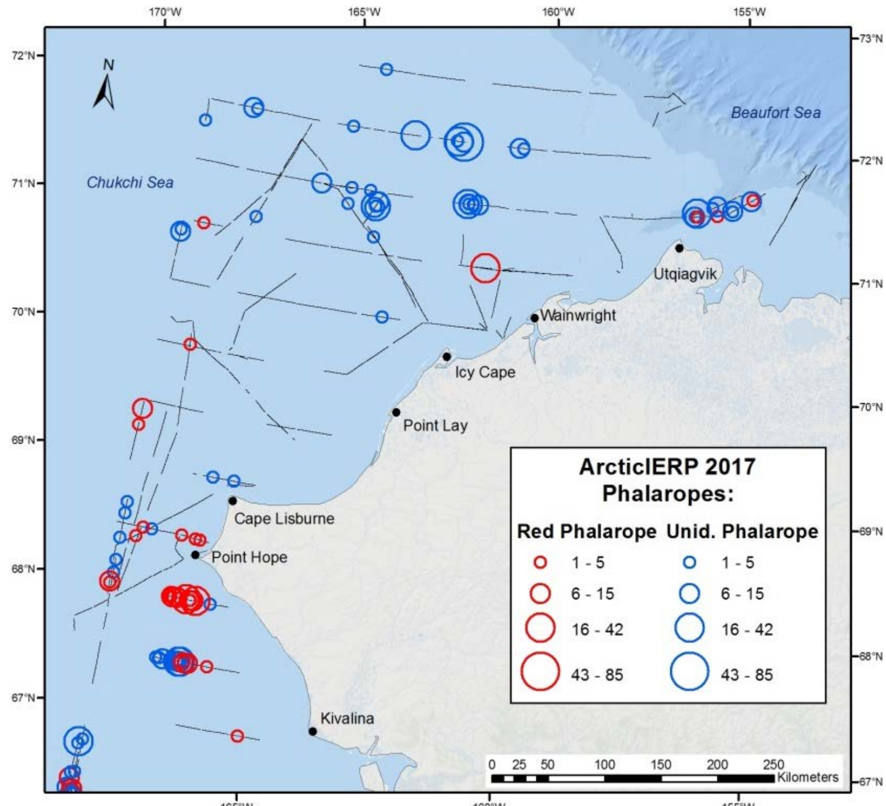


Figure K5: Distribution of phalaropes observed on transect during ArcticIERP 2017.

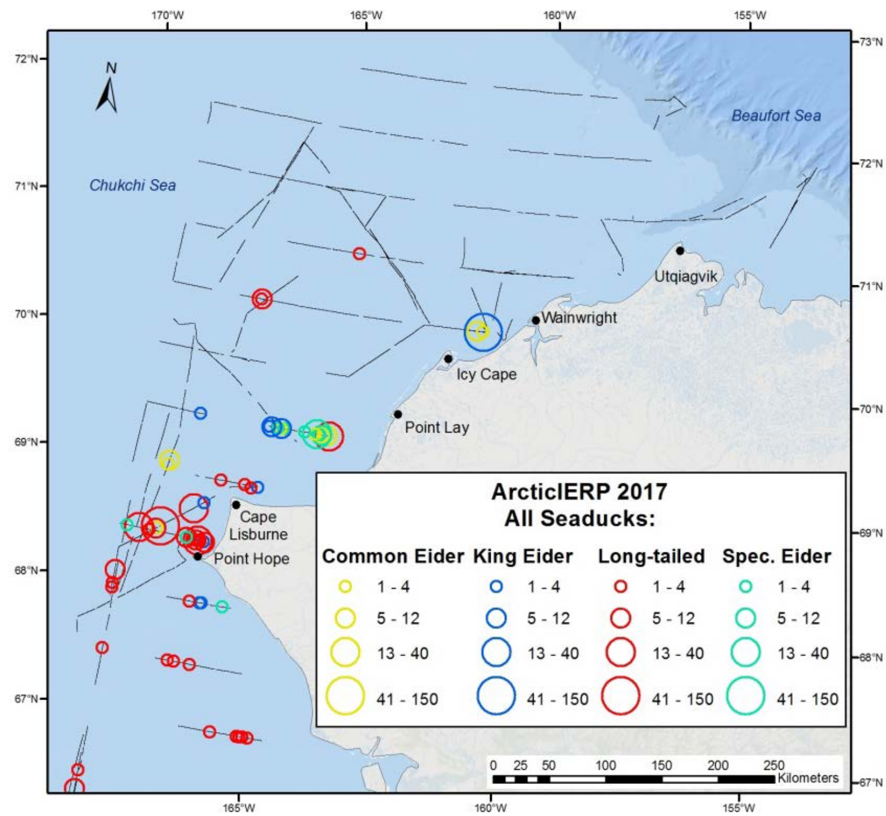


Figure K6: Distribution of all seaducks observed on and off transect during ArcticIERP 2017.

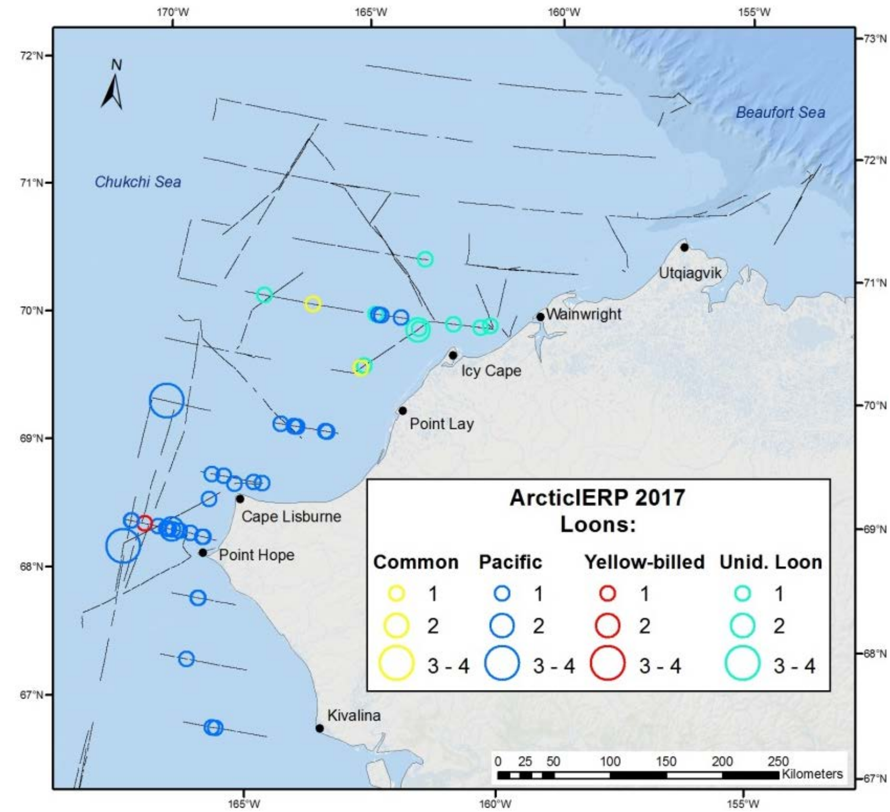


Figure K7: Distribution of loons observed on transect during ArcticIERP 2017.

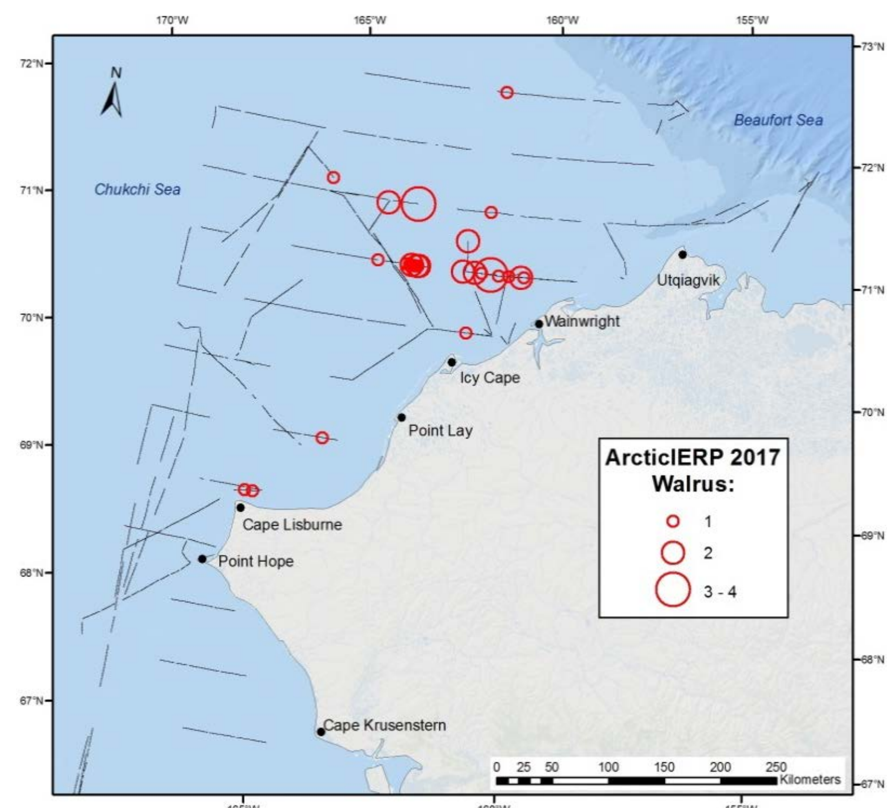


Figure K8: Distribution of all walrus observed on and off transect during ArcticIERP 2017.

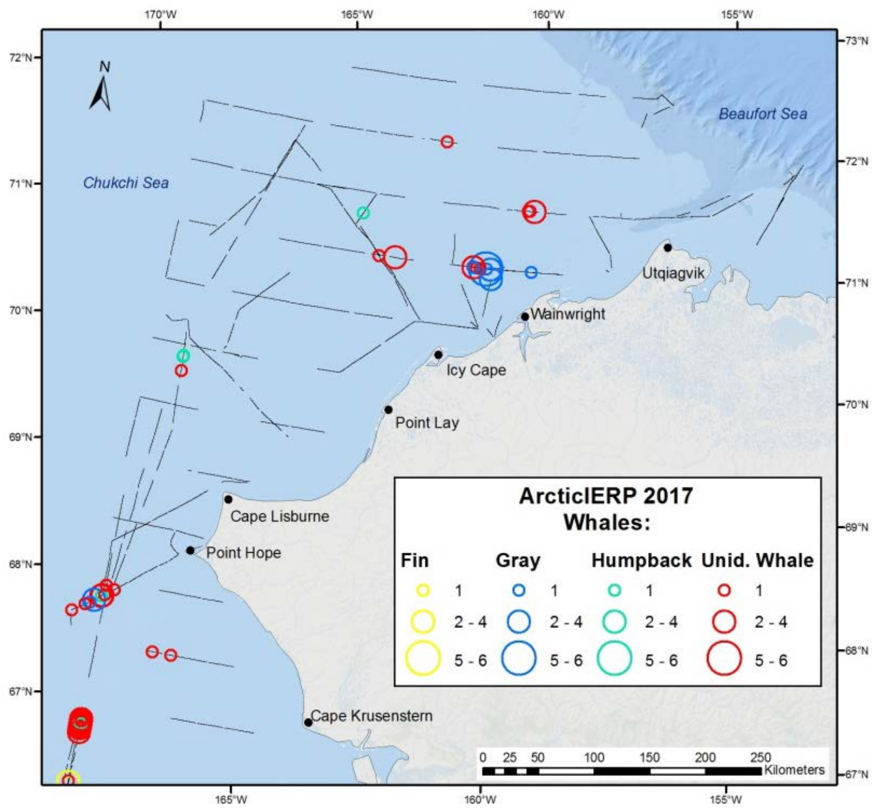


Figure K9: Distribution of all whales observed on and off transect during ArcticIERP 2017.

L. MOORINGS (Phyllis Stabeno, Carol Ladd, Geoff Lebon, Sigrid Salo, Ryan McCabe, Catherine Berchok, Chris Wilson)

i. *Biophysical Moorings* (G. Lebon)

Mooring operations for Leg 1 of the IERP survey consisted of 25 moorings recovered and 22 moorings deployed. These included 3 ice profiler moorings turned around, 8 ADCP (Acoustic Doppler Current Profiler) moorings turned around, 11 passive acoustic moorings turned around, 2 passive acoustic moorings recovered, and 1 TAPPS (Tracor Acoustic Plankton Profiling System) mooring recovered. All mooring operations were performed without incident or damage to any instrumentation. The TAPPS mooring and one passive acoustic mooring (Stafford) had to be recovered by dragging. A complete list of all instruments attached to each mooring are listed in Tables L1-L2.

The ITAE Mooring at the C2 site deployed by the USCG Cutter Healy in late July was observed to be in need of repairs. These repairs were successfully performed using the R/V Ocean Starr's small boat.

An additional three moorings were recovered during Leg 2 of the cruise: a passive acoustic mooring (NWFMAM) located on the northern Chukchi Sea continental slope near the 1000 m isobath with a single hydrophone near 500 m depth; a subsurface mooring near the mid shelf C2 location with a prototype SAMI alkalinity sensor near the bottom (ITAE-C); and a surface mooring at the C2 location with a meteorological package and subsurface instruments including the NOAA PMEL ITAE wire-crawling “Prawler” (ITAE-A). The acoustic release was lost during recovery of the Chukchi slope NWFMAM mooring; the two additional ITAE mooring recoveries were completed successfully without any issues.

ii. Passive Acoustic Moorings (C. Berchok)

The passive acoustics work on Leg one consisted of retrieving thirteen and redeploying eleven moorings. All but four of these moorings were located in clusters with the biophysical moorings as described above (Tables L1-L2), while three were co-located with both biophysical and active-acoustic fish detection moorings. One of these moorings (belonging to Kate Stafford) had an issue with its release (most likely an unexpected low-battery level), but was successfully retrieved via dragging; in big part due to the excellent boat handling skills of Captain Pete. All recovered moorings except one (16PAM_C2) contained a full year of data, which was extracted from the recorders and will be brought to Seattle for future analysis as funding permits. Results will consist of the long-term seasonal calling activity levels of nine species of marine mammals (bowhead, gray, humpback, minke, beluga, and killer whales, bearded and ribbon seals, and walrus), fish (work preliminary), two anthropogenic sound sources (airgun and vessel), and one environmental sound source (ice noise). In addition, quantitative measurements on the acoustic environment surrounding these mooring would be possible from these data.

iii. *Active Acoustics Moorings* (C. Wilson)

Three bottom-mounted upward-looking echosounders operating at 38, 70, and 200 kHz along with associated sensors (CTD, orientation) were deployed in the Chukchi Sea during Leg 1. These moorings will be used to describe seasonal changes in abundance and track the movement patterns of Arctic cod to understand the role of the Chukchi as a nursery area for this species. The first mooring (DAFT-1) was deployed on 7 Aug at 70° 0.818N, 166° 51.453W, the second (DAFT-2) on 9 Aug at 70° 50.135N, 163° 6.263W, and the third (DAFT-3) on 12 Aug at 71° 2.335N, 160° 30.212W. The units will be recovered and redeployed for another year during summer 2018.

Underway passive acoustic monitoring (C. Berchok)

Short-term passive acoustic monitoring was conducted opportunistically through the deployment of sonobuoys. Sonobuoys are short-term, expendable, listening devices which transmit the acoustic signals via VHF to an antenna on the ship. Maximum distance from the ship to the sonobuoys ranged from 11-14 nm (with tuned Morad VHF antenna). A total of 43 sonobuoys were deployed and 39 transmitted signals for a success rate of 91%. Of the 39 successful buoys, 3 were deployed in the Bering Sea, while 36 were deployed in the Chukchi Sea. Fin whales were the only species detected in the Bering Sea. In the Chukchi, the species detected were fin, humpback, bowhead, and gray whales (Fig. L1). As expected, these results support those of the bird observer for all but fin whales, which typically are heard more than seen on ship surveys, and porpoise, gray whales, and ice seals, which are typically seen more frequently than heard. Fin whales were the most commonly detected (28% of all sonobuoys deployed), followed by walrus (18%), bowhead and humpback whales (10% each), and gray whales (3%). No other species were detected. The biggest surprise were the number of sonobuoys deployed in the area between Wainwright and Utqiaviq (Barrow) that had positive detections of fin whale calls.

Table L1: Moorings recovered during Legs 1 & 2. ADCP=Acoustic Doppler Current Profiler, SUNA=nitrate, Eco Fl=fluorometer, SeaCat=conductivity, temperature, depth, MicroCat=conductivity, temperature, depth; Optode=oxygen sensor; MTR=temperature; SBETemp=temperature; Par=light radiation sensor; TAPS=Tracor Acoustic Plankton Profiling System; AURAL=passive acoustics; AWCP=fish finder; PAL=passive acoustics; CPOD=echolocation; ALK=alkalinity; MET / RAD=winds, radiation, temperature, humidity.

Mooring	ADCP	Ice Profiler	Current Meter	SUNA	Eco Fl	MTR	SeaCat	Micro Cat	Optode	SBE Temp	Par	TAPS	AURAL/ Temp/ Press	AWCP/ PAL/ CPOD	MET / RAD	ALK
16CKP1A	1			1	1	2	1				1					
16CKIP1A		1	1					1	1							
16PAM1A													1			
16CKP2A	1			1	1	2	1				1					
16CKIP2A		1	1					1	1							
16CKT2A												1				
16PAM2A													1			
16CKP3A	1			1	1		1				1					
16CKIP3A		1	1					1	1							
16PAM3A													1			
16CKP4A	1		1		1		1				1					
16PAM4A													1			
16CKP5A	1				1		1				1					
16PAM5A													1			
16CKP10A	1				1		1									
16PAM10A													1			
16CKP11A	1				1		1									
16PAM11A													1			
16CKP12A	1		1						1					1		
16PAM12A							1						1			
16PAM_CL1													1			
16PAM_NS1													1			
16PAM_NM1													1			
16PAM_BF1													1			
16PAM_BF2													1			
NWFMAM													1			
ITAE-A					2	1	1	2	1						1	
ITAE-C																1

Table L2: Moorings deployed during leg 1. ADCP=Acoustic Doppler Current Profiler, SUNA=nitrate, Eco Fl=fluorometer, SeaCat=conductivity, temperature, depth, MicroCat=conductivity, temperature, depth; Optode=oxygen sensor; MTR=temperature; SBETemp=temperature; Par=light radiation; TAPS= TracorAcoustic Plankton Profiling System; AURAL=passive acoustics; AWCP=fish finder; PAL=passive acoustics; CPOD=echolocation.

Mooring	ADCP	Ice Profiler	Current Meter	SUNA	Eco Fl	MTR	SeaCat	MicroCat	Optode	Par	DAFT	AURAL/ Temp/ Press	AWCP/ CPOD
17CKP1A	1			1	1	2	1			1			
17CKIP1A		1	1					1	1			1	
17PAM1A													
17DAFT 1A											1		
17CKP2A	1			1	1	2	1			1			
17CKIP2A		1	1					1	1			1	
17PAM2A													
17CKP3A	1			1	1		1			1			
17CKIP3A		1	1					1	1				
17PAM3A												1	
17CKP4A	1		1		1		1		1	1			
17PAM4A												1	
17DAFT4A											1		
17CKP5A	1				1		1	1		1			
17PAM5A												1	
17CKP10A	1				1		1						
17CKP11A	1				1		1						
17PAM11A												1	
17DAFT11A											1		
17CKP12A	1		1						1				1
17PAM12A							1					1	
17PAM_NS1												1	
17PAM_NM1												1	
17PAM_BF1												1	
17PAM_BF2												1	

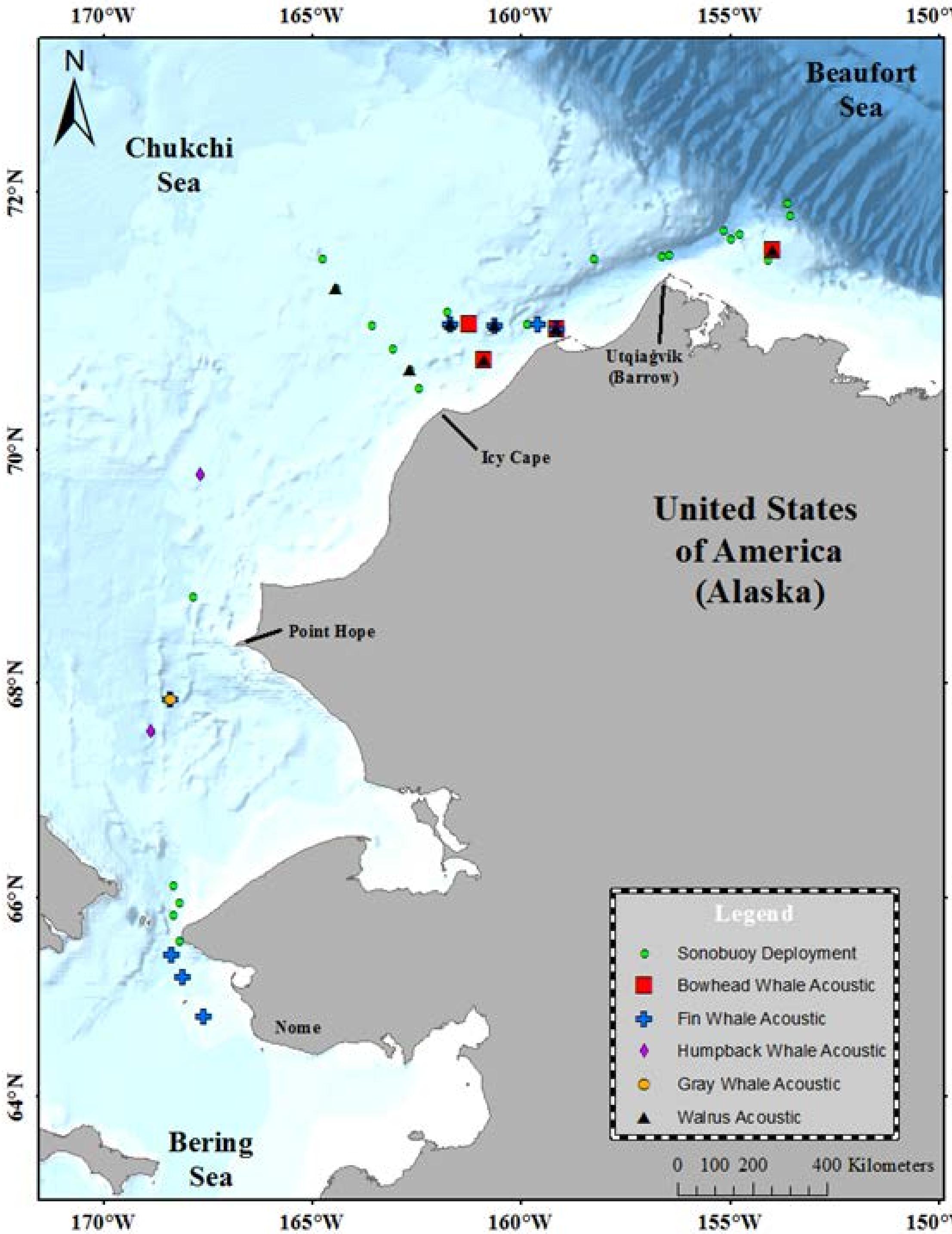


Fig. L1: Location of and species detected on all sonobuoy deployments in the Chukchi and western Beaufort Seas during leg 1 of the 2017 Arctic IERP survey. Deployments were made opportunistically by one technician, and so deployment positions were not evenly distributed along the cruise track.

M. INTERNATIONAL COLLABORATION (Ed Farley)

We were fortunate to have three Russian scientists on the survey during legs 2 and 3. Aleksey Somoff and Natalia Kuznetsova are from the TINRO Center in Vladivostok, Russia. Alexey is a Research Fish Biologist, specializing in marine ecology of fishes in the Arctic and western Bering Sea. Natalia Kuznetsova is a Marine Biologist, specializing in zooplankton ecology and fish diet. Igor Grigorov is from the VNIRO Center in Moscow, Russia. Igor is a Research Fish Biologist, specializing in marine ecology of fishes.

Aleksey Somoff (photo credit, Alicia Flores)

Natalia Kuznetsova (photo credit, Alicia Flores)

Igor Grigorov (photo credit, Alicia Flores)

N. ALASKA NATIVE SCIENCE AND ENGINEERING PROGRAM PARTICIPANTS

We were fortunate to have two ANSEP participants on our survey.

Harmony Wayner is an undergraduate student at the University of Alaska Southeast. Harmony participated during Leg 1 of our survey and assisted with collecting and processing oceanographic information and fish catch. Harmony also provided several "blogs" from the survey and gave an oral presented about her experience during the Strait Science talk in Nome, AK on August 25.

Harmony Wayner (credit Harmony Wayner)

Alicia Flores has an undergraduate degree in Biology. Alicia participated during Legs 2 and 3 of our survey and assisted with collecting and processing oceanographic information and fish catch. Alicia provided numerous "blogs" during the survey and gave an oral presentation about her experience during the Strait Science talk in Nome, AK on September 28.


Alicia Flores (credit Alicia Flores)

APPENDICIES

APPENDIX A: HYDROGRAPHIC TRANSECTS AND PLAN VIEW MAPS

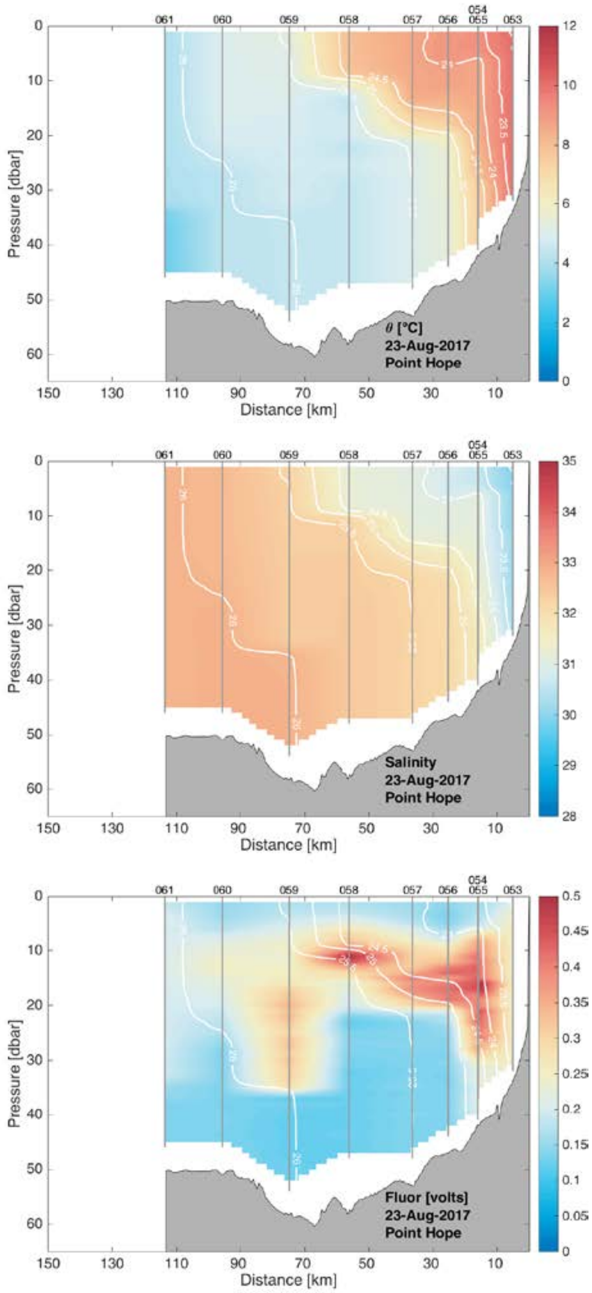


Fig. A1: Potential temperature (top), salinity (middle), and fluorescence (bottom) from the hydrographic transect off Point Hope. Data are not yet quality controlled.

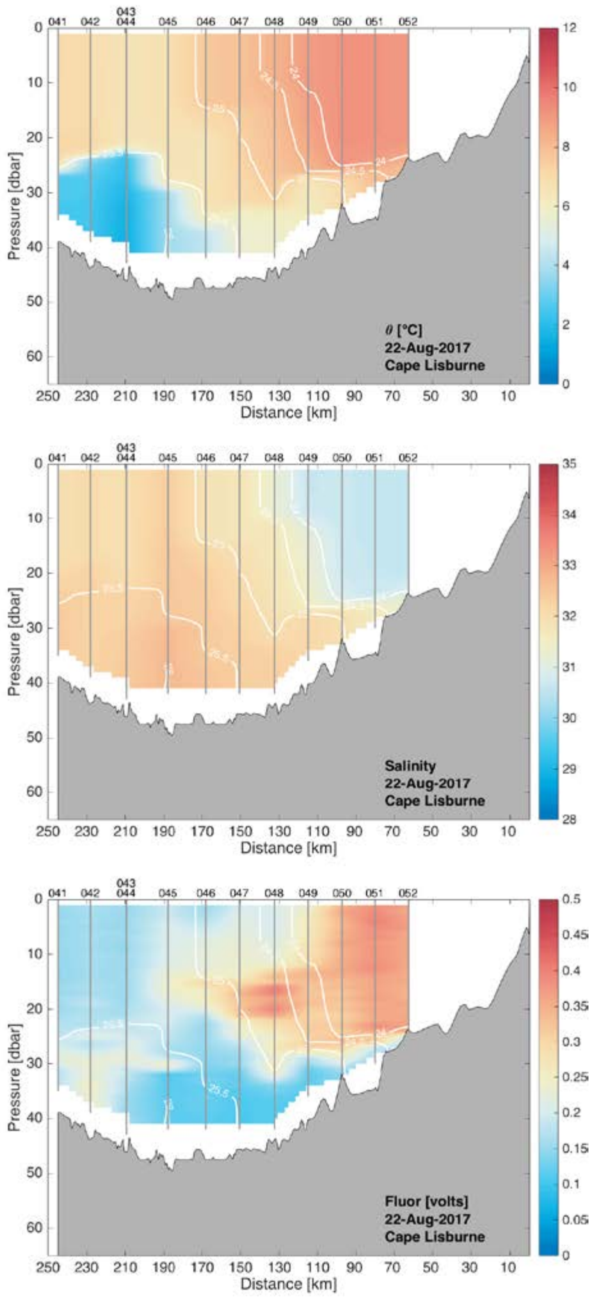


Fig. A2: Potential temperature (top), salinity (middle), and fluorescence (bottom) from the hydrographic transect near Cape Lisburne. Data are not yet quality controlled.

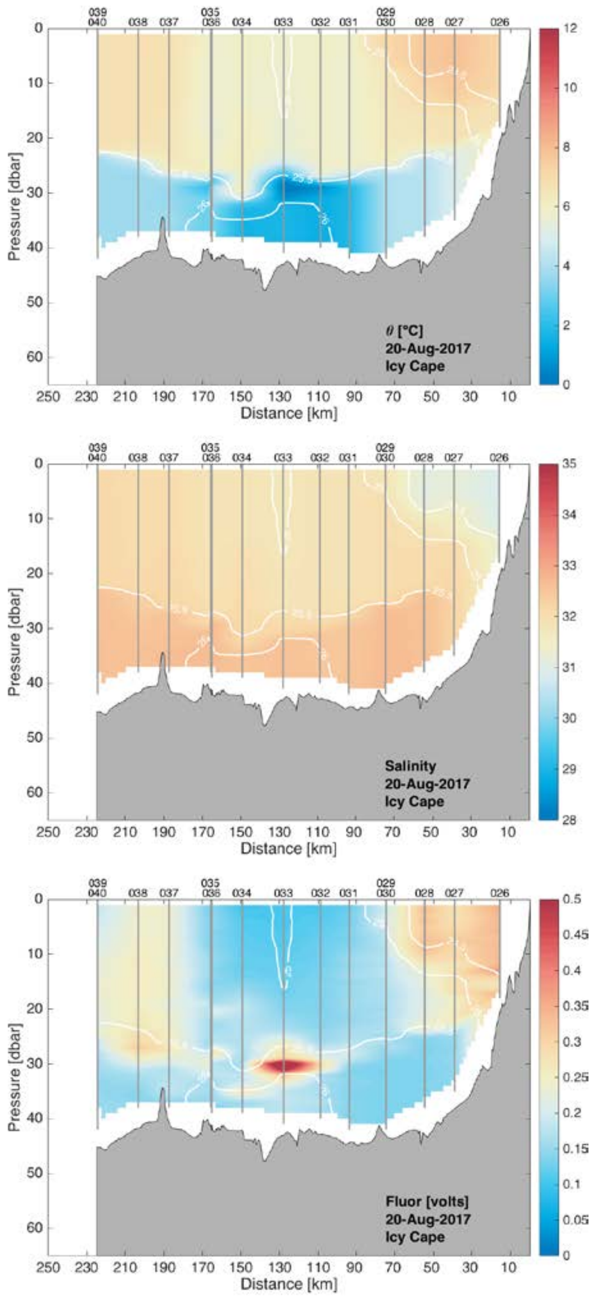


Fig. A3: Potential temperature (top), salinity (middle), and fluorescence (bottom) from the hydrographic transect off Icy Cape. Data are not yet quality controlled.

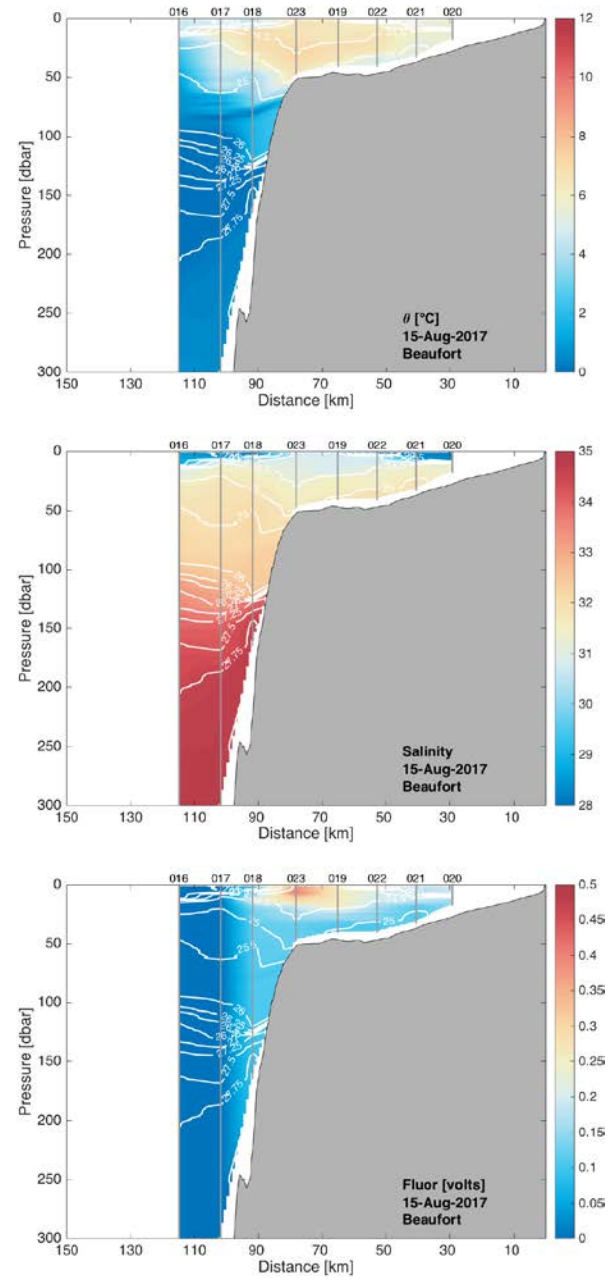


Fig. A4: Potential temperature (top), salinity (middle), and fluorescence (bottom) from the hydrographic transect over the Beaufort continental slope near Barrow. Data are not yet quality controlled.

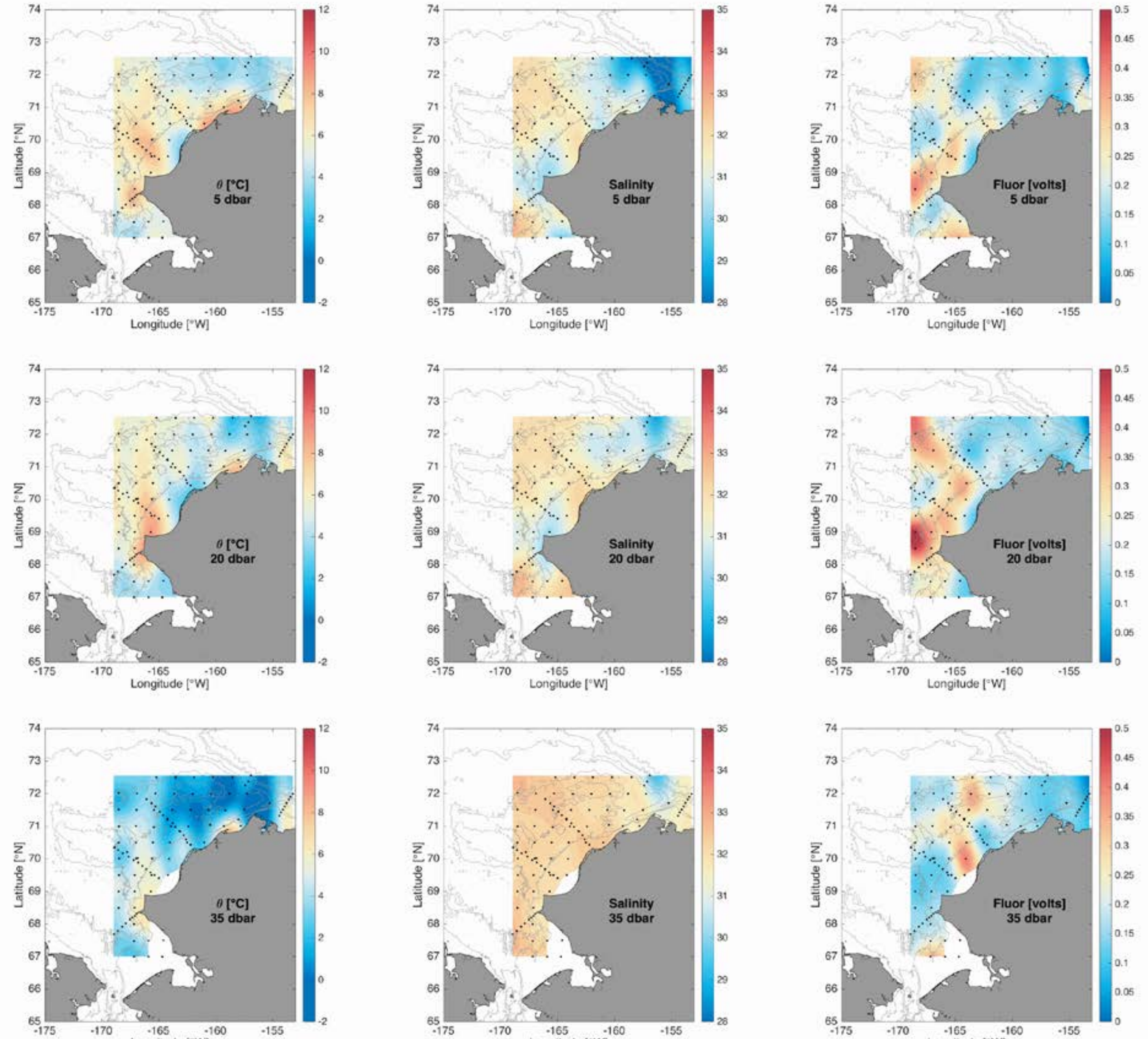


Fig. A5: Plan view maps of potential temperature (left column), salinity (middle column), and fluorescence (right column) at three depths (5, 20, and 35 dbar; top to bottom, respectively) over the Chukchi Sea shelf from hydrographic profiles collected Aug–Sep 2017 aboard the R/V *Ocean Starr*. Data are not yet quality controlled.

APPENDIX B: EVENT ACTIVITY LOG

LEG 1					
SURVEY	EVENT_ID	GEAR	DATE/TIME (GMT)	LATITUDE	LONGITUDE
AIES2017	11	CTD	08072017 08:38:28.900	70.2117	-167.7904
AIES2017	13	CTD	08072017 23:27:48.716	70.0179	-166.8499
AIES2017	15	CTD	08082017 00:02:38.161	70.0189	-166.8508
AIES2017	20	Bongo	08082017 14:54:18.499	71.2365	-164.216
AIES2017	21	CTD	08082017 15:20:12.121	71.2329	-164.221
AIES2017	29	CTD	08082017 18:48:44.113	71.2304	-164.2076
AIES2017	38	CTD	08092017 04:13:19.636	70.8375	-163.1214
AIES2017	78	Nordic	08092017 04:52:17.885	70.8238	-163.1138
AIES2017	79	Marinovich	08092017 06:00:43.549	70.7227	-162.9303
AIES2017	80	3m Beam Trawl	08092017 17:49:06.600		
AIES2017	81	CTD	08092017 21:15:50.615	70.4956	-161.1376
AIES2017	82	TowFish	08092017 21:17:35.950	70.4965	-161.1344
AIES2017	83	Bongo	08092017 21:19:23.440	70.497	-161.1299
AIES2017	84	CTD	08092017 21:22:19.437	70.4975	-161.123
AIES2017	85	Bongo	08092017 21:24:04.674	70.4982	-161.1191
AIES2017	39	CTD	08092017 21:52:17.735	70.5001	-160.996
AIES2017	40	Bongo	08092017 22:13:35.865	70.5021	-161.0054
AIES2017	41	3m Beam Trawl	08092017 23:53:13.059	70.5005	-161.0039
AIES2017	42	3m Beam Trawl	08102017 00:44:14.183	70.501	-161.0039
AIES2017	46	Bongo	08112017 14:54:28.680	71.0086	-159.2682
AIES2017	47	CTD	08112017 15:20:26.822	71.0019	-159.2901
AIES2017	48	CTD	08112017 15:45:59.133	71.0034	-159.2816
AIES2017	49	Nordic	08112017 17:16:23.557	70.9671	-159.187
AIES2017	50	Nordic	08112017 18:36:53.560	70.9815	-159.2053
AIES2017	51	3m Beam Trawl	08112017 20:07:36.626	71.0101	-159.281
AIES2017	88	CTD	08112017 23:56:12.685	71.0336	-160.515
AIES2017	89	CTD	08112017 23:57:15.148	71.0356	-160.5144
AIES2017	57	CTD	08122017 02:21:39.046	71.0322	-160.5006
AIES2017	90	Nordic	08122017 05:20:57.176	71.0035	-159.8367
AIES2017	60	3m Beam Trawl	08122017 14:49:46.942	70.994	-157.8033
AIES2017	92	3m Beam Trawl	08122017 14:49:46.942	70.994	-157.8033

AIES2017	61	Bongo	08122017 15:30:14.517	70.9977	-157.8009
AIES2017	93	Bongo	08122017 15:30:14.517	70.9977	-157.8009
AIES2017	62	CTD	08122017 15:45:34.463	71.0011	-157.8026
AIES2017	65	Nordic	08122017 17:14:37.276	71.0821	-158.0496
AIES2017	71	CTD	08122017 20:34:50.698	71.2002	-158.0159
AIES2017	74	Marinovich	08132017 02:33:58.584	71.5089	-157.8996
AIES2017	76	Nordic	08132017 15:05:38.198	71.4878	-157.5423
AIES2017	77	Bongo	08132017 16:44:13.293	71.5026	-157.4985
AIES2017	78	CTD	08132017 17:13:53.209	71.4986	-157.5115
AIES2017	79	CTD	08132017 17:42:37.928	71.4956	-157.5121
AIES2017	80	3m Beam Trawl	08132017 19:18:00.377	71.4913	-157.5398
AIES2017	93	CTD	08142017 14:59:38.007	71.9929	-153.2248
AIES2017	94	Bongo	08142017 15:40:32.138	71.9923	-153.1793
AIES2017	100	CTD	08142017 22:28:40.898	71.8971	-153.4467
AIES2017	103	CTD	08142017 23:49:15.468	71.8157	-153.5774
AIES2017	104	Bongo	08152017 01:30:24.382	71.8133	-153.5757
AIES2017	107	Bongo	08152017 04:00:56.877	71.6038	-153.9403
AIES2017	108	CTD	08152017 04:14:20.390	71.6031	-153.9286
AIES2017	111	3m Beam Trawl	08152017 15:23:21.190	71.3356	-154.415
AIES2017	112	Bongo	08152017 15:57:36.475	71.3198	-154.4305
AIES2017	113	CTD	08152017 16:08:19.052	71.3201	-154.4212
AIES2017	116	CTD	08152017 17:29:30.800	71.4125	-154.2756
AIES2017	117	Bongo	08152017 17:38:02.012	71.4139	-154.266
AIES2017	122	CTD	08152017 21:04:56.359	71.507	-154.1042
AIES2017	124	Marinovich	08152017 22:52:46.992	71.5879	-153.9752
AIES2017	125	Nordic	08162017 01:15:04.817	71.5806	-153.9785
AIES2017	127	CTD	08162017 04:02:08.741	71.7075	-153.7579
AIES2017	128	Marinovich	08162017 05:33:19.609	71.7622	-153.6704
AIES2017	135	Marinovich	08172017 18:43:04.185	71.0019	-159.7181
AIES2017	130	CTD	08172017 20:50:00.000	71.7128	-156.2413
AIES2017	138	CTD	08172017 23:50:26.754	70.9987	-160.7924
AIES2017	140	CTD	08172017 23:57:25.058	70.9984	-160.7885
AIES2017	142	Nordic	08182017 01:47:05.131	70.9991	-160.6949
AIES2017	143	3m Beam Trawl	08182017 03:01:02.520	70.9952	-160.5451
AIES2017	144	CTD	08182017 03:44:20.853	70.9928	-160.5238

AIES2017	149	Marinovich	08182017 17:05:00.935	70.9995	-161.1644
AIES2017	152	Nordic	08192017 00:45:15.521	70.5662	-161.1957
AIES2017	155	Bongo	08192017 14:01:12.968	70.4326	-162.2064
AIES2017	156	CTD	08192017 14:10:27.724	70.4322	-162.1951
AIES2017	158	CTD	08192017 15:57:22.903	70.5989	-162.5927
AIES2017	162	Bongo	08192017 17:15:03.674	70.7192	-162.8333
AIES2017	163	CTD	08192017 17:27:11.266	70.7176	-162.8209
AIES2017	166	CTD	08192017 18:59:26.847	70.8521	-163.1813
AIES2017	167	CTD	08192017 19:20:28.451	70.8497	-163.1856
AIES2017	170	Bongo	08192017 20:51:23.933	70.9765	-163.5532
AIES2017	171	CTD	08192017 21:05:17.715	70.9767	-163.5419
AIES2017	174	CTD	08192017 22:16:56.416	71.0875	-163.7911
AIES2017	177	Bongo	08192017 23:44:18.119	71.1994	-164.1976
AIES2017	178	CTD	08192017 23:56:54.452	71.1975	-164.205
AIES2017	181	CTD	08202017 01:33:42.607	71.3397	-164.6058
AIES2017	184	CTD	08202017 02:55:01.332	71.4523	-164.9146
AIES2017	187	Bongo	08202017 14:05:44.280	71.4462	-164.9195
AIES2017	188	CTD	08202017 14:18:05.258	71.4421	-164.9259
AIES2017	189	CTD	08202017 15:59:45.447	71.603	-165.2999
AIES2017	191	Bongo	08202017 17:17:33.428	71.7049	-165.6169
AIES2017	192	CTD	08202017 17:28:15.652	71.7033	-165.6261
AIES2017	195	CTD	08202017 19:04:18.491	71.8284	-166.079
AIES2017	196	CTD	08202017 19:26:11.770	71.8295	-166.0812
AIES2017	94	CTD	08202017 22:29:15.836	71.7562	-166.1538
AIES2017	95	Marinovich	08202017 22:38:52.481	71.7353	-166.1784
AIES2017	96	Benthic Grab	08202017 22:52:19.009	71.7057	-166.2141
AIES2017	97	Marinovich	08202017 22:56:51.277	71.6958	-166.2261
AIES2017	100	Marinovich	08202017 23:19:23.626	71.647	-166.2854
AIES2017	205	CTD	08212017 14:06:54.419	70.3491	-168.9034
AIES2017	206	CTD	08212017 15:32:21.782	70.2613	-168.5405
AIES2017	208	CTD	08212017 17:01:54.614	70.1655	-168.135
AIES2017	209	CTD	08212017 17:24:21.004	70.1654	-168.139
AIES2017	215	CTD	08212017 20:38:10.559	70.061	-167.654
AIES2017	218	CTD	08212017 22:15:12.521	69.9601	-167.2214
AIES2017	221	CTD	08212017 23:37:26.208	69.8839	-166.8194

AIES2017	224	CTD	08222017 01:11:57.287	69.7856	-166.4435
AIES2017	227	CTD	08222017 02:47:52.034	69.6883	-166.085
AIES2017	230	CTD	08222017 04:17:30.761	69.5841	-165.7391
AIES2017	233	CTD	08222017 05:37:09.777	69.5005	-165.3738
AIES2017	238	CTD	08222017 06:58:53.140	69.4099	-164.999
AIES2017	241	CTD	08222017 18:21:22.669	68.3135	-166.9317
AIES2017	244	CTD	08222017 19:31:32.158	68.2439	-167.1184
AIES2017	245	CTD	08222017 19:52:03.565	68.2459	-167.1201
AIES2017	248	CTD	08222017 20:43:06.508	68.1949	-167.306
AIES2017	251	CTD	08222017 21:41:06.263	68.1304	-167.5106
AIES2017	253	CTD	08222017 23:10:18.421	68.0129	-167.8635
AIES2017	258	CTD	08232017 01:42:00.131	67.9076	-168.2148
AIES2017	261	CTD	08232017 03:25:20.470	67.7867	-168.5916
AIES2017	264	CTD	08232017 05:07:22.800	67.689	-168.9358
AIES2017	102	Marinovich	08242017 20:37:44.706	64.4951	-165.4378
Leg 2					
SURVEY	EVENT_ID	GEAR	EQ_TIME	EQ_LATITUDE	EQ_LONGITUDE
AIES2017	103	3m Beam Trawl	08252017 20:19:06.519	64.4951	-165.4378
AIES2017	104	3m Beam Trawl	08252017 20:24:59.073	64.4951	-165.4377
AIES2017	105	Marinovich	08282017 20:27:31.376	71.0287	-166.9363
AIES2017	106	Bongo	08292017 13:57:47.372	72.4947	-165.2032
AIES2017	272	Juday	08292017 14:30:30.483	72.4975	-165.192
AIES2017	273	CTD	08292017 14:41:19.749	72.4983	-165.1845
AIES2017	274	Bongo	08292017 14:59:40.629	72.4998	-165.1721
AIES2017	275	3m Beam Trawl	08292017 15:51:19.106	72.5082	-165.1523
AIES2017	276	Marinovich	08292017 19:06:11.446	72.4943	-164.3412
AIES2017	279	CTD	08292017 22:41:49.091	72.4983	-163.5096
AIES2017	280	Juday	08292017 22:58:52.081	72.4952	-163.511
AIES2017	281	CTD	08292017 23:21:34.376	72.4908	-163.5137
AIES2017	282	Bongo	08292017 23:37:04.959	72.4927	-163.5099
AIES2017	283	3m Beam Trawl	08292017 23:55:43.950	72.5001	-163.4926
AIES2017	286	Marinovich	08302017 02:46:07.028	72.5028	-163.088
AIES2017	289	Juday	08302017 14:12:18.620	72.497	-161.8973
AIES2017	290	CTD	08302017 14:21:38.786	72.4952	-161.8952
AIES2017	291	Bongo	08302017 14:34:49.173	72.4934	-161.8856

AIES2017	292	3m Beam Trawl	08302017 15:02:04.067	72.5019	-161.9048
AIES2017	293	3m Beam Trawl	08302017 15:22:56.304	72.4992	-161.8941
AIES2017	296	CTD	08302017 19:45:04.423	72.4995	-160.2113
AIES2017	297	Bongo	08302017 20:03:49.952	72.4976	-160.2133
AIES2017	298	Benthic Grab	08302017 20:17:18.684	72.4961	-160.2132
AIES2017	299	CTD	08302017 20:28:16.902	72.4947	-160.2135
AIES2017	300	Bongo	08302017 20:42:42.830	72.4897	-160.2114
AIES2017	301	3m Beam Trawl	08302017 21:09:38.896	72.4716	-160.2184
AIES2017	302	Marinovich	08302017 22:11:43.417	72.5133	-160.2532
AIES2017	305	Juday	08312017 03:33:45.419	72.4993	-158.518
AIES2017	306	CTD	08312017 03:51:06.371	72.4979	-158.5237
AIES2017	307	Bongo	08312017 04:18:14.379	72.49	-158.5201
AIES2017	308	3m Beam Trawl	08312017 04:41:58.000	72.4812	-158.499
AIES2017	309	3m Beam Trawl	08312017 05:10:06.782	72.4699	-158.4637
AIES2017	312	Marinovich	08312017 16:46:16.431	72.5169	-157.2401
AIES2017	314	CTD	08312017 20:16:38.164	72.5561	-156.9133
AIES2017	315	Bongo	08312017 20:49:16.918	72.5556	-156.9485
AIES2017	319	CTD	09012017 01:51:29.909	72.3748	-157.1609
AIES2017	320	Bongo	09012017 02:23:24.273	72.3738	-157.1944
AIES2017	321	3m Beam Trawl	09012017 02:56:35.293	72.3712	-157.2288
AIES2017	323	CTD	09012017 04:41:16.777	72.2527	-157.4186
AIES2017	324	Bongo	09012017 05:05:31.404	72.2459	-157.4328
AIES2017	325	3m Beam Trawl	09012017 05:30:50.568	72.2372	-157.4294
AIES2017	326	Juday	09012017 14:16:01.077	72.0006	-157.2145
AIES2017	327	CTD	09012017 14:33:32.742	72.0012	-157.2176
AIES2017	328	Bongo	09012017 14:54:31.587	71.9946	-157.2313
AIES2017	329	3m Beam Trawl	09012017 15:17:13.043	71.9893	-157.1998
AIES2017	332	Marinovich	09012017 19:13:22.683	72.0038	-158.3105
AIES2017	335	CTD	09012017 21:32:07.931	72.0003	-158.7707
AIES2017	336	Juday	09012017 21:43:38.341	71.9996	-158.781
AIES2017	337	Benthic Grab	09012017 21:55:45.964	71.9984	-158.791
AIES2017	338	CTD	09012017 22:10:00.449	71.997	-158.8022
AIES2017	339	Bongo	09012017 22:22:34.532	71.9938	-158.8088
AIES2017	340	3m Beam Trawl	09012017 22:36:33.407	71.9914	-158.7968
AIES2017	342	Juday	09022017 03:06:46.539	71.9993	-160.3964

AIES2017	343	CTD	09022017 03:17:33.462	71.9985	-160.4041
AIES2017	344	Bongo	09022017 03:31:16.224	71.9937	-160.4065
AIES2017	345	3m Beam Trawl	09022017 03:43:32.687	71.9895	-160.3922
AIES2017	348	CTD	09022017 15:14:28.078	71.9981	-161.9993
AIES2017	349	Juday	09022017 15:24:32.097	71.9972	-162.0066
AIES2017	350	Benthic Grab	09022017 15:37:26.376	71.996	-162.0164
AIES2017	351	CTD	09022017 15:49:04.243	71.995	-162.0252
AIES2017	352	Bongo	09022017 15:58:44.521	71.9923	-162.0249
AIES2017	353	3m Beam Trawl	09022017 16:14:03.558	71.9857	-162.0132
AIES2017	355	Marinovich	09022017 19:05:22.529	72.0134	-162.7969
AIES2017	358	CTD	09022017 22:06:36.217	71.9993	-163.6632
AIES2017	359	Juday	09022017 22:16:45.078	71.9996	-163.6694
AIES2017	360	Benthic Grab	09022017 22:24:34.921	71.9998	-163.674
AIES2017	361	Benthic Grab	09022017 22:31:26.050	72	-163.678
AIES2017	362	Bongo	09022017 22:40:40.953	71.9967	-163.6826
AIES2017	363	3m Beam Trawl	09022017 22:56:40.201	71.9941	-163.6675
AIES2017	366	Marinovich	09032017 01:10:58.656	72.0004	-164.3182
AIES2017	369	Bongo	09032017 14:05:39.058	72.0013	-165.2974
AIES2017	370	Benthic Grab	09032017 14:13:16.106	72.0023	-165.3007
AIES2017	371	CTD	09032017 14:20:38.476	72.0034	-165.3039
AIES2017	372	Bongo	09032017 14:31:55.471	72.0023	-165.3105
AIES2017	373	3m Beam Trawl	09032017 14:44:54.664	71.9972	-165.3066
AIES2017	376	CTD	09032017 18:55:03.159	72.0009	-166.8963
AIES2017	377	Juday	09032017 19:05:16.311	72.0033	-166.9003
AIES2017	378	Benthic Grab	09032017 19:13:36.176	72.0052	-166.9036
AIES2017	379	CTD	09032017 19:24:57.924	72.0081	-166.9078
AIES2017	380	Bongo	09032017 19:37:28.165	72.0089	-166.9181
AIES2017	381	3m Beam Trawl	09032017 19:51:41.398	72.0061	-166.9397
AIES2017	382	Marinovich	09032017 20:41:44.355	72.008	-166.8977
AIES2017	385	Juday	09042017 02:02:45.129	72.0014	-168.5099
AIES2017	386	Juday	09042017 02:10:06.150	72.0042	-168.511
AIES2017	387	Benthic Grab	09042017 02:20:03.758	72.0079	-168.5129
AIES2017	388	CTD	09042017 02:34:58.605	72.0137	-168.513
AIES2017	389	Bongo	09042017 02:54:47.354	72.0193	-168.5305
AIES2017	390	3m Beam Trawl	09042017 03:13:11.577	72.0138	-168.542

AIES2017	393	Juday	09042017 14:07:49.461	71.5024	-168.4981
AIES2017	394	Benthic Grab	09042017 14:15:46.003	71.5049	-168.5003
AIES2017	395	CTD	09042017 14:27:03.570	71.5085	-168.502
AIES2017	396	Bongo	09042017 14:42:34.048	71.51	-168.5108
AIES2017	397	CTD	09042017 14:56:35.107	71.5109	-168.5191
AIES2017	398	3m Beam Trawl	09042017 15:12:26.907	71.5094	-168.5213
AIES2017	399	3m Beam Trawl	09042017 15:30:12.463	71.5015	-168.5195
AIES2017	400	Marinovich	09042017 16:13:41.616	71.4762	-168.5058
AIES2017	403	CTD	09042017 21:08:04.670	71.5004	-166.9294
AIES2017	404	Juday	09042017 21:12:54.763	71.5011	-166.9307
AIES2017	405	Benthic Grab	09042017 21:18:57.464	71.5021	-166.9321
AIES2017	406	CTD	09042017 21:39:45.186	71.5057	-166.9395
AIES2017	407	Bongo	09042017 21:50:06.331	71.5067	-166.9506
AIES2017	408	3m Beam Trawl	09042017 22:01:25.801	71.5042	-166.9512
AIES2017	411	Marinovich	09052017 00:17:30.420	71.5047	-166.3122
AIES2017	414	Juday	09052017 14:04:57.746	71.5003	-165.403
AIES2017	415	CTD	09052017 14:10:17.876	71.5007	-165.4059
AIES2017	416	Benthic Grab	09052017 14:16:55.538	71.501	-165.41
AIES2017	417	Bongo	09052017 14:25:49.636	71.4989	-165.4098
AIES2017	418	3m Beam Trawl	09052017 14:40:41.898	71.4945	-165.3931
AIES2017	419	Marinovich	09052017 16:49:13.034	71.5032	-164.9592
AIES2017	421	CTD	09052017 20:30:36.536	71.4985	-163.8094
AIES2017	422	Juday	09052017 20:31:16.270	71.4985	-163.8097
AIES2017	423	Benthic Grab	09052017 20:39:57.425	71.4988	-163.814
AIES2017	424	CTD	09052017 20:55:44.118	71.4992	-163.8224
AIES2017	425	Bongo	09052017 21:05:38.790	71.4975	-163.8292
AIES2017	426	3m Beam Trawl	09052017 21:16:52.373	71.4933	-163.8401
AIES2017	429	CTD	09062017 00:26:00.090	71.2221	-164.2519
AIES2017	433	Bongo	09062017 14:05:52.126	71.4988	-162.2081
AIES2017	434	CTD	09062017 14:10:28.172	71.4985	-162.2099
AIES2017	435	Benthic Grab	09062017 14:22:19.741	71.4977	-162.2147
AIES2017	436	Bongo	09062017 14:32:41.656	71.4948	-162.2087
AIES2017	437	3m Beam Trawl	09062017 14:49:47.210	71.4916	-162.1843
AIES2017	438	Marinovich	09062017 15:42:12.326	71.4953	-162.188
AIES2017	441	CTD	09062017 20:45:04.256	71.501	-160.6115

AIES2017	442	Juday	09062017 20:50:37.088	71.5008	-160.6161
AIES2017	443	Benthic Grab	09062017 21:04:09.806	71.4998	-160.6275
AIES2017	444	CTD	09062017 21:16:18.598	71.4988	-160.6383
AIES2017	445	Bongo	09062017 21:27:58.702	71.4959	-160.6469
AIES2017	446	3m Beam Trawl	09062017 21:51:49.545	71.4903	-160.6211
AIES2017	447	Marinovich	09062017 22:36:00.527	71.5044	-160.6447
AIES2017	450	Bongo	09072017 04:38:22.608	71.4974	-159.1152
AIES2017	451	Benthic Grab	09072017 04:51:54.408	71.4949	-159.1327
AIES2017	452	CTD	09072017 05:10:13.904	71.492	-159.157
AIES2017	453	Bongo	09072017 05:24:22.852	71.4858	-159.1693
AIES2017	454	3m Beam Trawl	09072017 05:46:02.966	71.4779	-159.1526
AIES2017	459	Juday	09092017 14:02:51.536	70.9984	-162.4094
AIES2017	460	CTD	09092017 14:08:13.544	70.9973	-162.4151
AIES2017	461	Benthic Grab	09092017 14:25:11.122	70.9938	-162.4337
AIES2017	462	Bongo	09092017 14:43:56.033	70.9886	-162.4433
AIES2017	463	3m Beam Trawl	09092017 15:04:03.432	70.9899	-162.4219
AIES2017	465	Marinovich	09092017 17:54:20.115	71.0046	-163.3644
AIES2017	468	CTD	09092017 20:19:50.881	70.998	-163.9047
AIES2017	469	Juday	09092017 20:21:19.724	70.9978	-163.9062
AIES2017	470	Benthic Grab	09092017 20:28:40.989	70.9969	-163.9137
AIES2017	471	CTD	09092017 20:43:29.244	70.9951	-163.929
AIES2017	472	Bongo	09092017 20:54:23.046	70.9916	-163.9368
AIES2017	473	3m Beam Trawl	09092017 21:06:22.895	70.9892	-163.9309
AIES2017	476	Marinovich	09102017 01:20:34.310	70.9979	-165.3749
AIES2017	477	Juday	09102017 02:08:35.286	70.9766	-165.4002
AIES2017	478	Benthic Grab	09102017 02:20:36.332	70.9747	-165.4127
AIES2017	479	CTD	09102017 02:39:17.799	70.9718	-165.4314
AIES2017	480	Bongo	09102017 02:53:17.247	70.9657	-165.4392
AIES2017	481	3m Beam Trawl	09102017 03:10:58.796	70.9619	-165.4255
AIES2017	483	Juday	09102017 14:04:55.399	71.0007	-167.0158
AIES2017	484	CTD	09102017 14:06:29.295	71.0007	-167.0171
AIES2017	485	Benthic Grab	09102017 14:16:33.885	71.0009	-167.0258
AIES2017	486	Bongo	09102017 14:29:45.991	70.9969	-167.0236
AIES2017	487	3m Beam Trawl	09102017 14:47:45.754	70.9977	-167.0051
AIES2017	488	Marinovich	09102017 17:38:51.612	71.0135	-167.7706

AIES2017	489	Juday	09102017 20:28:35.342	70.9992	-168.4972
AIES2017	490	CTD	09102017 20:32:52.462	70.9992	-168.4997
AIES2017	491	Benthic Grab	09102017 20:42:34.941	70.9996	-168.505
AIES2017	492	CTD	09102017 20:53:58.592	71	-168.5109
AIES2017	493	Bongo	09102017 21:02:44.190	70.9981	-168.5136
AIES2017	494	3m Beam Trawl	09102017 21:16:52.816	70.9949	-168.502
AIES2017	497	CTD	09112017 01:35:17.517	70.4988	-168.5031
AIES2017	498	Juday	09112017 01:36:44.747	70.4988	-168.5039
AIES2017	499	Benthic Grab	09112017 01:42:50.007	70.4988	-168.5075
AIES2017	500	Bongo	09112017 01:55:20.131	70.4961	-168.5126
AIES2017	501	3m Beam Trawl	09112017 02:13:08.344	70.4939	-168.4958
AIES2017	504	Juday	09112017 14:05:08.348	70.4992	-166.9977
AIES2017	505	CTD	09112017 14:06:57.224	70.4991	-166.9986
AIES2017	506	Benthic Grab	09112017 14:17:39.873	70.499	-167.0037
AIES2017	507	Bongo	09112017 14:26:42.741	70.497	-167.0005
AIES2017	508	3m Beam Trawl	09112017 14:42:04.431	70.4994	-166.9875
AIES2017	509	Marinovich	09112017 15:14:31.404	70.5055	-167.0335
AIES2017	511	Juday	09112017 20:01:25.708	70.4993	-165.5063
AIES2017	512	CTD	09112017 20:05:01.220	70.4991	-165.5064
AIES2017	513	Benthic Grab	09112017 20:26:34.841	70.4987	-165.5128
AIES2017	514	CTD	09112017 20:35:11.178	70.4986	-165.5152
AIES2017	515	Bongo	09112017 20:44:52.659	70.4972	-165.5112
AIES2017	516	3m Beam Trawl	09112017 20:58:33.010	70.4937	-165.5162
AIES2017	519	Marinovich	09122017 00:12:28.249	70.5047	-164.5496
AIES2017	522	Juday	09122017 02:20:23.541	70.4996	-164.0025
AIES2017	523	Benthic Grab	09122017 02:29:36.573	70.501	-164.0019
AIES2017	524	CTD	09122017 02:41:01.957	70.5023	-163.9996
AIES2017	525	Bongo	09122017 02:53:11.044	70.5054	-164.0028
AIES2017	526	3m Beam Trawl	09122017 03:08:52.153	70.5057	-164.0203
AIES2017	529	Juday	09122017 14:02:57.752	70.4995	-162.5046
AIES2017	530	CTD	09122017 14:06:22.475	70.4998	-162.5074
AIES2017	531	Benthic Grab	09122017 14:16:45.246	70.5004	-162.5159
AIES2017	532	Bongo	09122017 14:28:14.204	70.4979	-162.5178
AIES2017	533	3m Beam Trawl	09122017 14:40:18.455	70.4948	-162.5047
AIES2017	534	Nordic	09122017 15:45:54.053	70.5124	-162.4189

AIES2017	535	CTD	09122017 17:07:19.287	70.5014	-162.5062
AIES2017	538	Juday	09122017 23:18:12.400	69.9987	-164.098
AIES2017	539	CTD	09122017 23:21:07.882	69.9987	-164.0993
AIES2017	540	Benthic Grab	09122017 23:28:52.972	69.9993	-164.1033
AIES2017	541	Bongo	09122017 23:36:05.504	69.998	-164.1079
AIES2017	542	3m Beam Trawl	09122017 23:48:04.298	69.9975	-164.0988
AIES2017	543	Nordic	09132017 00:49:56.930	70.0219	-164.0228
AIES2017	546	Juday	09132017 14:04:45.396	70.0016	-165.5927
AIES2017	547	CTD	09132017 14:09:03.067	70.0024	-165.5873
AIES2017	548	Benthic Grab	09132017 14:18:33.764	70.0041	-165.576
AIES2017	549	Bongo	09132017 14:28:17.691	70.0072	-165.5729
AIES2017	550	3m Beam Trawl	09132017 14:41:38.135	70.0067	-165.5862
AIES2017	551	3m Beam Trawl	09132017 15:08:20.414	70.0003	-165.6072
AIES2017	552	Marinovich	09132017 15:43:26.109	69.9919	-165.6478
AIES2017	555	Marinovich	09132017 21:07:21.442	70.0013	-166.9001
AIES2017	556	Bongo	09132017 22:28:20.939	70.0033	-166.9981
AIES2017	557	Benthic Grab	09132017 22:39:07.057	70.005	-166.9852
AIES2017	558	CTD	09132017 22:53:48.338	70.007	-166.9681
AIES2017	559	Bongo	09132017 23:00:30.144	70.011	-166.9626
AIES2017	560	3m Beam Trawl	09132017 23:11:04.884	70.0123	-166.952
AIES2017	562	Juday	09142017 04:30:39.461	70.0022	-168.5004
AIES2017	563	Benthic Grab	09142017 04:39:57.553	70.0043	-168.49
AIES2017	565	CTD	09142017 04:51:35.868	70.007	-168.4776
AIES2017	566	Bongo	09142017 05:03:28.149	70.0119	-168.4698
AIES2017	567	3m Beam Trawl	09142017 05:18:54.559	70.0118	-168.4755
Leg 3					
SURVEY	EVENT_ID	GEAR	EQ_TIME	EQ_LATITUDE	EQ_LONGITUDE
AIES2017	609	Juday	09192017 16:05:39.919	69.4986	-164.1996
AIES2017	610	CTD	09192017 16:16:07.444	69.4979	-164.2001
AIES2017	611	Benthic Grab	09192017 16:28:48.596	69.4667	-164.2
AIES2017	612	Bongo	09192017 16:39:40.000	69.4987	-164.1908
AIES2017	613	3m Beam Trawl	09192017 16:52:53.683	69.5037	-164.1909
AIES2017	614	CTD	09192017 17:10:19.127	69.5056	-164.1962
AIES2017	615	Nordic	09192017 18:18:59.815	69.5364	-164.2539
AIES2017	616	Nordic	09192017 19:18:50.583	69.5559	-164.3311

AIES2017	621	Marinovich	09202017 00:28:34.461	69.4966	-165.3315
AIES2017	624	Nordic	09202017 03:08:05.874	69.5089	-165.6518
AIES2017	625	Juday	09202017 04:34:00.000	69.499	-165.6357
AIES2017	626	Benthic Grab	09202017 04:42:41.932	69.499	-165.6357
AIES2017	627	CTD	09202017 04:53:58.994	69.4976	-165.6325
AIES2017	628	Bongo	09202017 05:07:14.954	69.4965	-165.6191
AIES2017	629	3m Beam Trawl	09202017 05:25:46.037	69.5012	-165.6004
AIES2017	630	Juday	09202017 16:01:56.995	69.4983	-167.0965
AIES2017	631	CTD	09202017 16:14:26.050	69.4956	-167.0945
AIES2017	632	Benthic Grab	09202017 16:22:12.133	69.4939	-167.0933
AIES2017	633	Bongo	09202017 16:39:19.569	69.4925	-167.0875
AIES2017	634	3m Beam Trawl	09202017 16:52:45.235	69.4969	-167.0812
AIES2017	635	Marinovich	09202017 18:03:04.728	69.4984	-167.1727
AIES2017	641	Juday	09202017 22:23:32.017	69.505	-168.4931
AIES2017	640	CTD	09202017 22:27:39.868	69.5047	-168.4922
AIES2017	642	Benthic Grab	09202017 22:44:24.956	69.503	-168.4901
AIES2017	643	Bongo	09202017 22:55:22.234	69.5038	-168.4813
AIES2017	644	CTD	09202017 23:08:13.682	69.5051	-168.4721
AIES2017	645	3m Beam Trawl	09202017 23:22:21.055	69.5049	-168.4633
AIES2017	646	Marinovich	09212017 00:05:45.869	69.5034	-168.4346
AIES2017	651	Juday	09212017 04:31:19.088	68.9957	-168.4984
AIES2017	652	CTD	09212017 04:44:22.789	68.9907	-168.5043
AIES2017	653	Benthic Grab	09212017 05:01:40.523	68.9847	-168.5139
AIES2017	654	Bongo	09212017 05:13:27.093	68.9797	-168.5093
AIES2017	655	3m Beam Trawl	09212017 05:28:43.786	68.9815	-168.4974
AIES2017	656	Juday	09212017 16:03:53.197	68.999	-167.0981
AIES2017	657	CTD	09212017 16:14:16.602	68.9958	-167.1075
AIES2017	658	Benthic Grab	09212017 16:20:54.278	68.994	-167.1139
AIES2017	659	Bongo	09212017 16:31:22.224	68.991	-167.1107
AIES2017	660	3m Beam Trawl	09212017 16:44:04.186	68.992	-167.1001
AIES2017	661	Nordic	09212017 17:27:33.112	68.9992	-167.0538
AIES2017	662	CTD	09212017 19:08:06.228	68.9973	-167.109
AIES2017	667	Marinovich	09212017 21:26:14.010	68.9938	-166.8777
AIES2017	672	Juday	09222017 02:49:13.754	68.9974	-165.6982
AIES2017	673	CTD	09222017 02:55:46.161	68.9961	-165.7041

AIES2017	674	Benthic Grab	09222017 03:01:27.000	68.995	-165.709
AIES2017	675	Bongo	09222017 03:11:12.737	68.9917	-165.7137
AIES2017	676	3m Beam Trawl	09222017 03:22:32.556	68.9898	-165.7024
AIES2017	681	Juday	09232017 18:51:51.328	68.5004	-167.0975
AIES2017	682	CTD	09232017 19:03:47.854	68.4975	-167.1024
AIES2017	683	Benthic Grab	09232017 19:17:31.296	68.4944	-167.108
AIES2017	684	Bongo	09232017 19:25:56.294	68.4954	-167.0998
AIES2017	685	3m Beam Trawl	09232017 19:40:00.235	68.4994	-167.0831
AIES2017	686	Nordic	09232017 20:32:09.163	68.4955	-167.1072
AIES2017	689	Marinovich	09242017 00:22:02.007	68.514	-167.7731
AIES2017	692	Juday	09242017 03:45:19.050	68.4962	-168.5096
AIES2017	693	CTD	09242017 03:52:19.423	68.4936	-168.5161
AIES2017	694	Benthic Grab	09242017 03:59:59.269	68.4908	-168.5231
AIES2017	695	CTD	09242017 04:13:22.179	68.4856	-168.5354
AIES2017	696	Bongo	09242017 04:21:05.822	68.4812	-168.5378
AIES2017	697	3m Beam Trawl	09242017 04:36:44.236	68.4698	-168.5521
AIES2017	698	Juday	09242017 16:00:47.114	67.9984	-165.7998
AIES2017	699	Benthic Grab	09242017 16:17:07.258	67.9935	-165.803
AIES2017	700	Bongo	09242017 16:24:08.580	67.9919	-165.7974
AIES2017	701	CTD	09242017 16:35:41.715	67.9891	-165.7936
AIES2017	702	3m Beam Trawl	09242017 16:46:03.392	67.9887	-165.7854
AIES2017	703	Nordic	09242017 17:41:52.741	67.9502	-165.7999
AIES2017	708	Marinovich	09242017 23:01:30.692	68.0138	-166.6334
AIES2017	711	Nordic	09252017 02:18:20.224	67.9876	-167.1705
AIES2017	712	Juday	09252017 04:22:30.291	67.9943	-167.1855
AIES2017	713	Bongo	09252017 04:29:42.104	67.9916	-167.1786
AIES2017	714	CTD	09252017 04:52:47.143	67.9827	-167.1696
AIES2017	715	3m Beam Trawl	09252017 05:04:38.704	67.9752	-167.1747
AIES2017	716	3m Beam Trawl	09252017 05:27:29.298	67.967	-167.1646
AIES2017	717	Juday	09252017 10:14:40.777	67.9984	-168.4987
AIES2017	718	Juday	09252017 10:31:11.400	67.9897	-168.4956
AIES2017	719	Bongo	09252017 10:41:59.430	67.9868	-168.4831
AIES2017	720	3m Beam Trawl	09252017 10:58:34.816	67.9882	-168.4634
AIES2017	721	Juday	09252017 16:36:35.640	67.4985	-167.1991
AIES2017	722	Bongo	09252017 16:46:00.689	67.4954	-167.1897

AIES2017	723	3m Beam Trawl	09252017 17:04:45.632	67.4896	-167.172
AIES2017	724	CTD	09252017 17:31:24.544	67.4791	-167.1586
AIES2017	729	Juday	09252017 22:06:30.230	67.496	-165.8945
AIES2017	730	CTD	09252017 22:22:44.601	67.4878	-165.8922
AIES2017	731	Bongo	09252017 22:33:49.567	67.4825	-165.8858
AIES2017	732	3m Beam Trawl	09252017 22:47:44.761	67.4825	-165.8752
AIES2017	733	Nordic	09252017 23:30:52.430	67.4857	-165.9171
AIES2017	736	Marinovich	09262017 02:49:16.359	67.4661	-165.5682
AIES2017	739	Juday	09262017 06:55:04.161	67.4984	-164.583
AIES2017	740	CTD	09262017 07:06:35.002	67.493	-164.5811
AIES2017	741	Bongo	09262017 07:16:08.227	67.4889	-164.5739
AIES2017	742	3m Beam Trawl	09262017 07:29:35.152	67.4888	-164.5742
AIES2017	743	Juday	09262017 16:04:12.225	67.001	-164.6977
AIES2017	744	CTD	09262017 16:13:41.780	66.9974	-164.6996
AIES2017	745	Bongo	09262017 16:22:33.366	66.9937	-164.6954
AIES2017	746	3m Beam Trawl	09262017 16:35:55.042	66.9864	-164.6893
AIES2017	747	Nordic	09262017 17:58:15.516	66.9338	-164.7483
AIES2017	751	Juday	09262017 23:00:30.602	66.9993	-165.8999
AIES2017	753	CTD	09262017 23:08:34.109	66.9998	-165.8991
AIES2017	754	Bongo	09262017 23:16:18.798	67.0001	-165.8959
AIES2017	755	3m Beam Trawl	09262017 23:27:30.617	67.0036	-165.8917
AIES2017	756	Nordic	09272017 00:42:52.627	67.0307	-165.8881
AIES2017	759	Marinovich	09272017 03:06:31.660	67.0064	-166.1689
AIES2017	762	Juday	09272017 07:15:00.235	66.9976	-167.1652
AIES2017	763	CTD	09272017 07:23:02.453	66.9974	-167.164
AIES2017	764	Bongo	09272017 07:35:08.895	66.9991	-167.1587
AIES2017	765	3m Beam Trawl	09272017 07:48:43.899	67.0034	-167.145